GTE-ERS
TECHNICAL LIBRARY
03867

ESC-1259-92-01

SENCORE

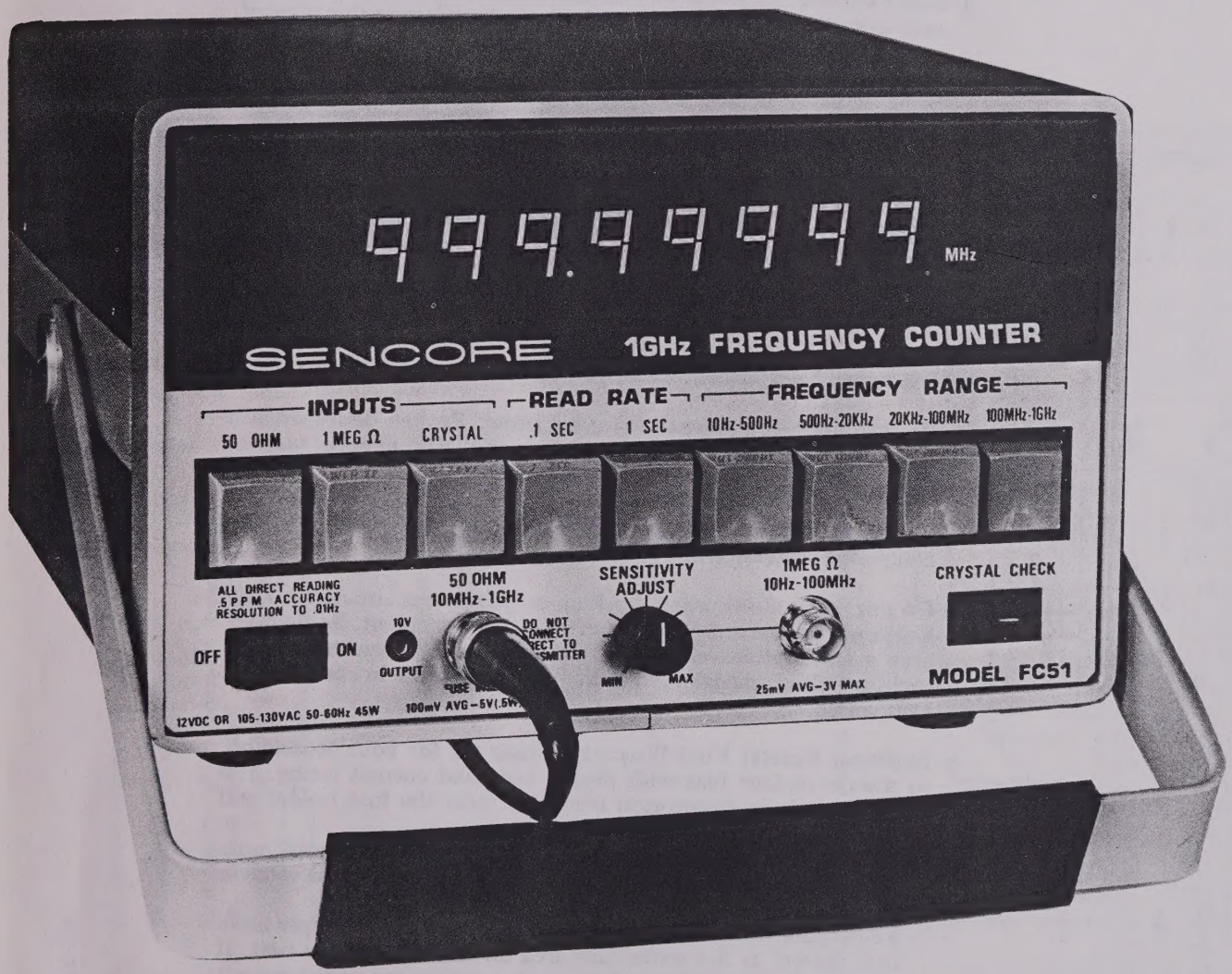
FC51

1GHz FREQUENCY COUNTER

FC51

1GHz Frequency Counter

Operation, Application and Maintenance Manual



THE ANALYZER PEOPLE

SENCORE

WARNING

PLEASE OBSERVE THESE SAFETY PRECAUTIONS

There is always a danger present when testing electronic equipment. Unexpected high voltages can be present at unusual locations in defective equipment. Become familiar with the equipment you're working with, and observe the following safety precautions.

Every precaution has been taken in the design of your instrument to insure that it is as safe as possible. **However, safe operation depends on you, the operator.**

1. **Never exceed the limits of this instrument** as given in the specifications section and the additional special warnings in this manual.

2. **A severe shock hazard can result** if the chassis of the equipment being serviced is tied to the "hot" side of the AC Line. An isolation transformer should always be used with this equipment. Also, be sure that the top of your workbench and the floor underneath it are dry and made of non-conductive material.

3. **Remove the circuit power before making connections** to high voltage points. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket and stand on an insulated floor to reduce the possibility of shock.

4. **Discharge filter capacitors** before connecting test leads to them.

5. **Be sure your equipment is in good order.** Broken or frayed test leads can be extremely dangerous and can expose you to dangerous voltages.

6. **Remove the test leads** immediately after the test has been completed to reduce the possibility of shock.

7. **Do not work alone** when working on hazardous circuits. Always have another person close by in case of an accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with high voltages.

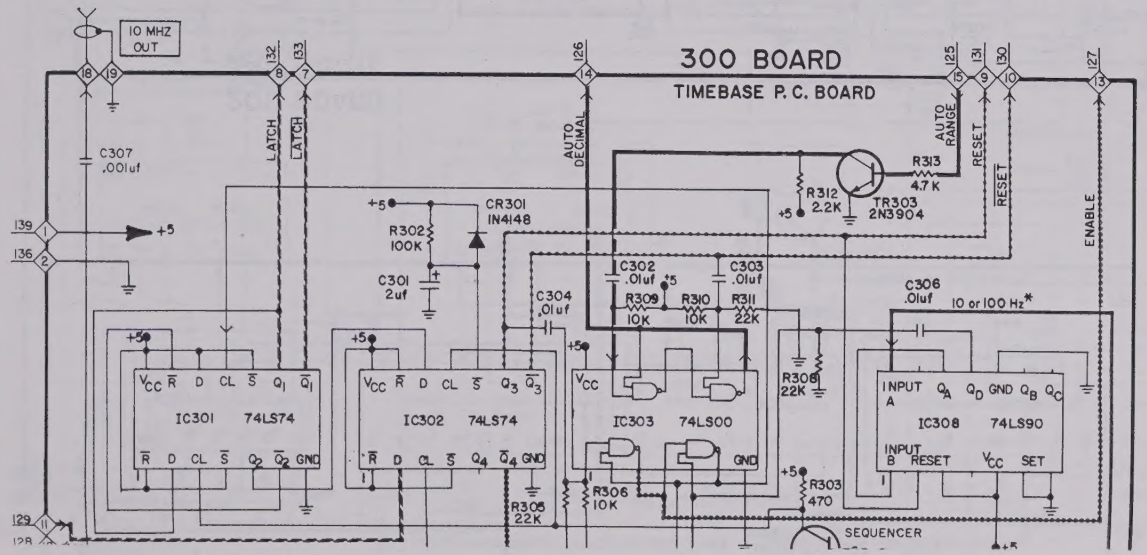
8. **Improper Fuse(s) Void Warranty.** Fuses are for your protection, so always replace fuse with proper type and current rating. The proper fuse type description is marked near the fuse holder and in the instruction manual. Always:
   a. **Be sure you are replacing the right fuse.** On units with more than one fuse, be sure you are placing the proper fuse value in the fuse holder.
   b. **Keep spare fuse storage area stocked.** Always have proper sized fuse stored in the spare fuse area on the back of the unit. If you use the spare fuse, always put a new spare of the proper value in the holder.
   c. **Have the proper size replacement fuse in stock.** With each new instrument, be sure to update your fuse inventory with any special value fuses your instrument may require.
   d. **Avoid situations that will blow the fuse.** When a protection fuse blows, note what caused the fuse failure. Prevent future fuse failures by following proper measuring procedures.

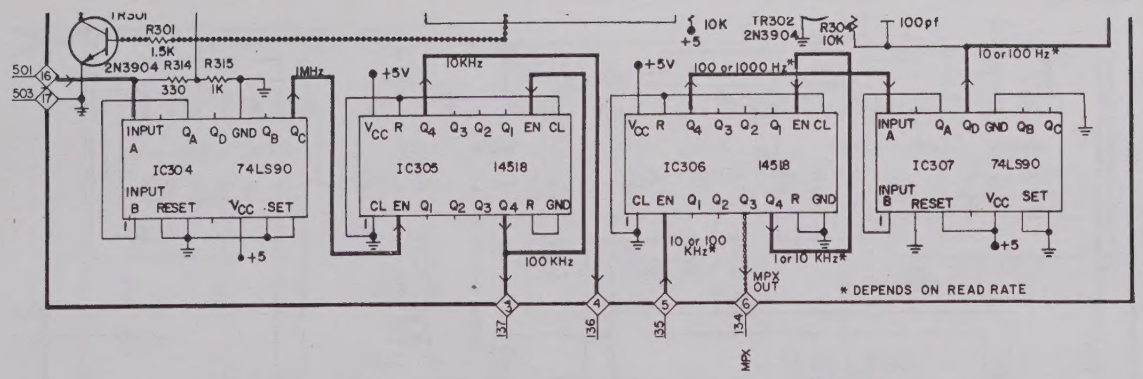
NOTES:

1. All resistances shown in ohms.
2. All capacitors are as specified.
3. First number of interconnects shows board number, second and third show terminal number. Example: 121 goes to 100 board, terminal 21.
4. [ ] Denotes front panel control name.

Color Legend

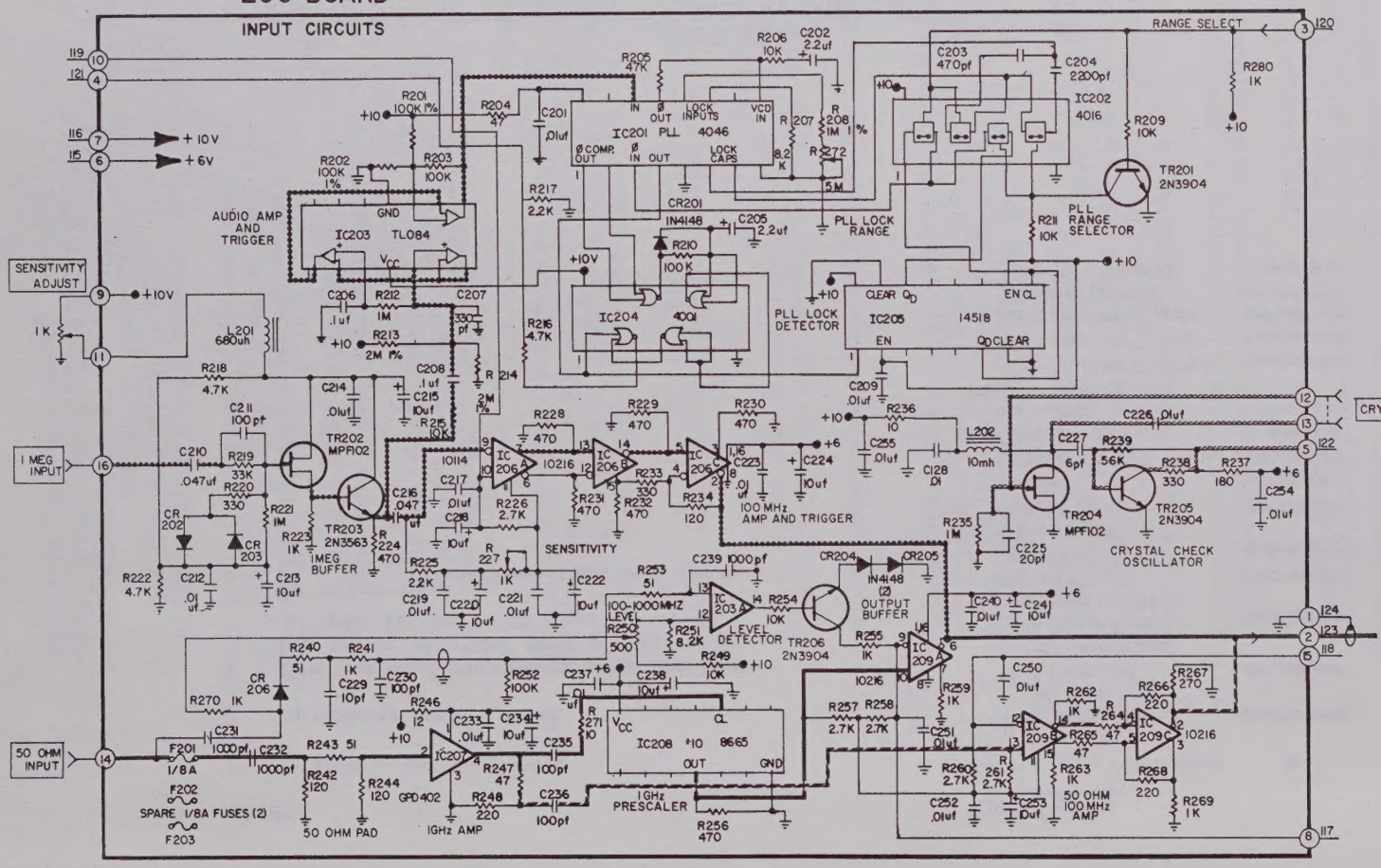
- Power Supply Connections
- Frequency Signals
  - Main Signal Path (50 Ohm Input)
  - 10:1 Prescaled (50 Ohm Input)
  - Main Signal Path (1 Meg Input)
  - Crystal Check
  - Overflow
- Timebase Signal
  - Divided Clock
  - Enable
  - Latch & Latch
  - Reset & Reset
  - Multiplex
- Decimal Control
  - Auto Decimal Control
  - Auto Decimal Output
  - Auto Decimal Enable
  - 100 MHz Control
  - 0100 MHz Control

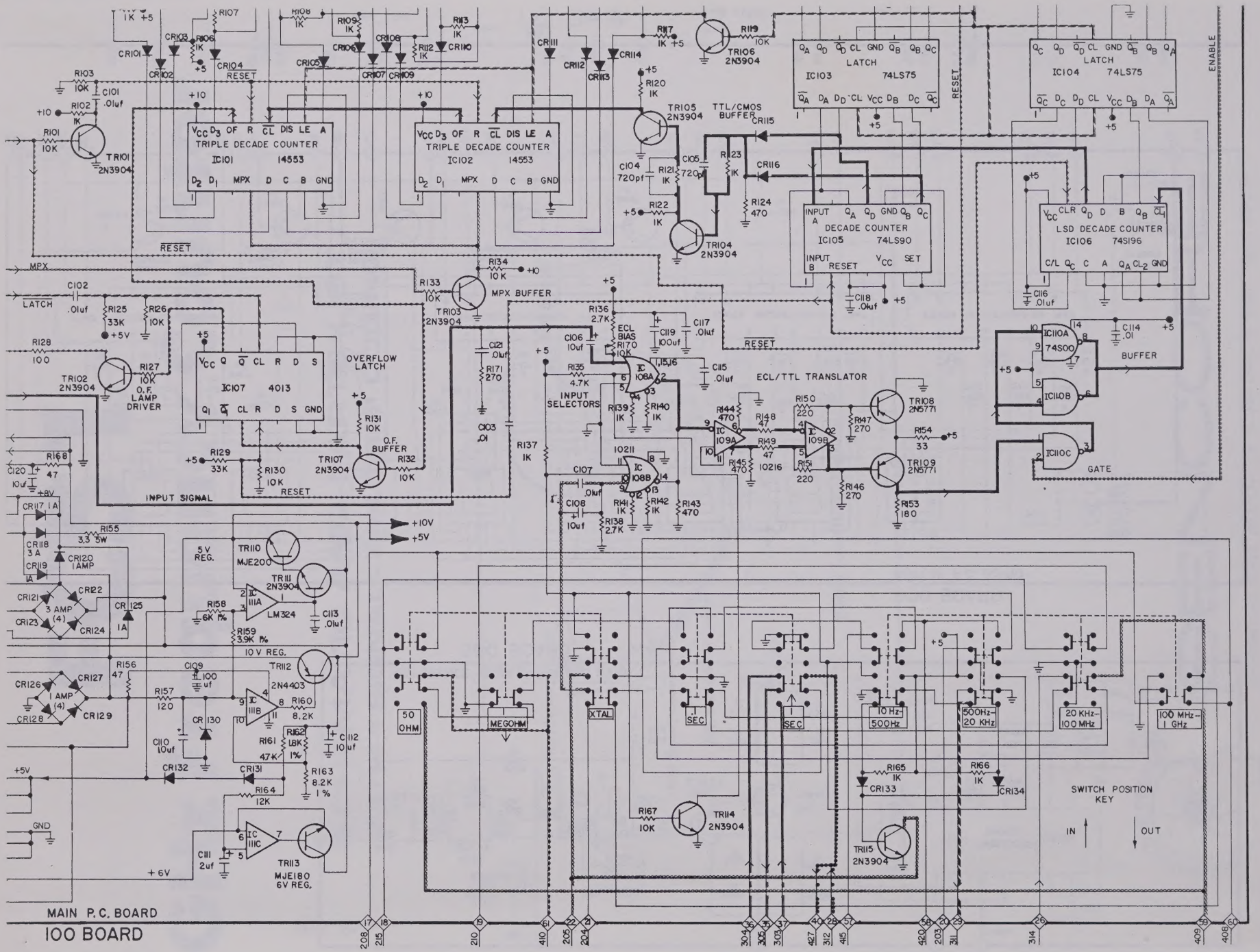


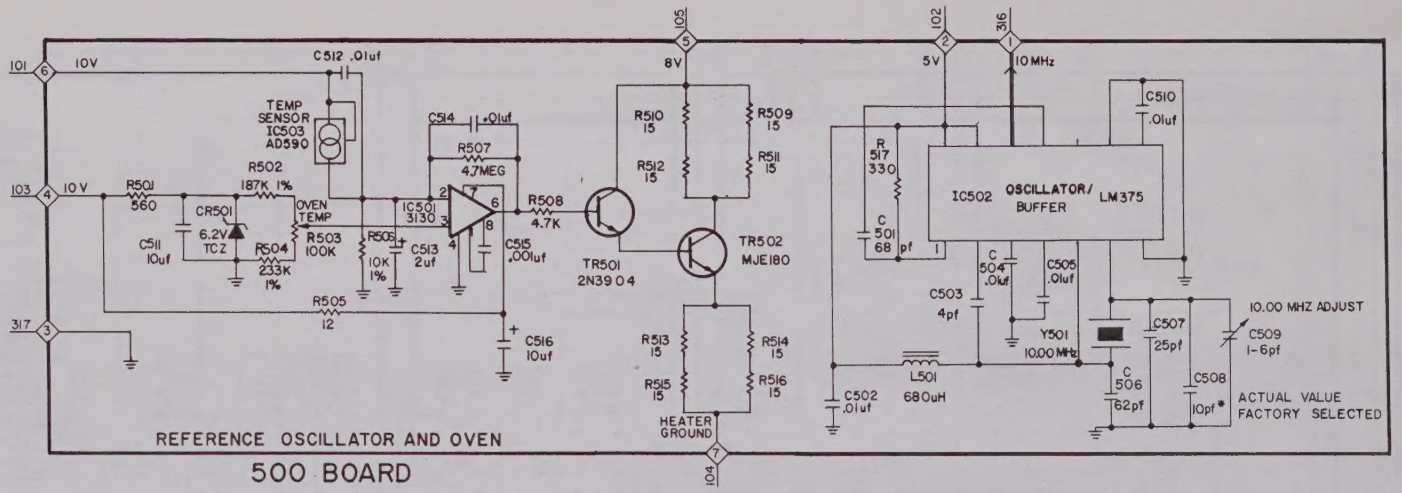


200 BOARD

INPUT CIRCUITS

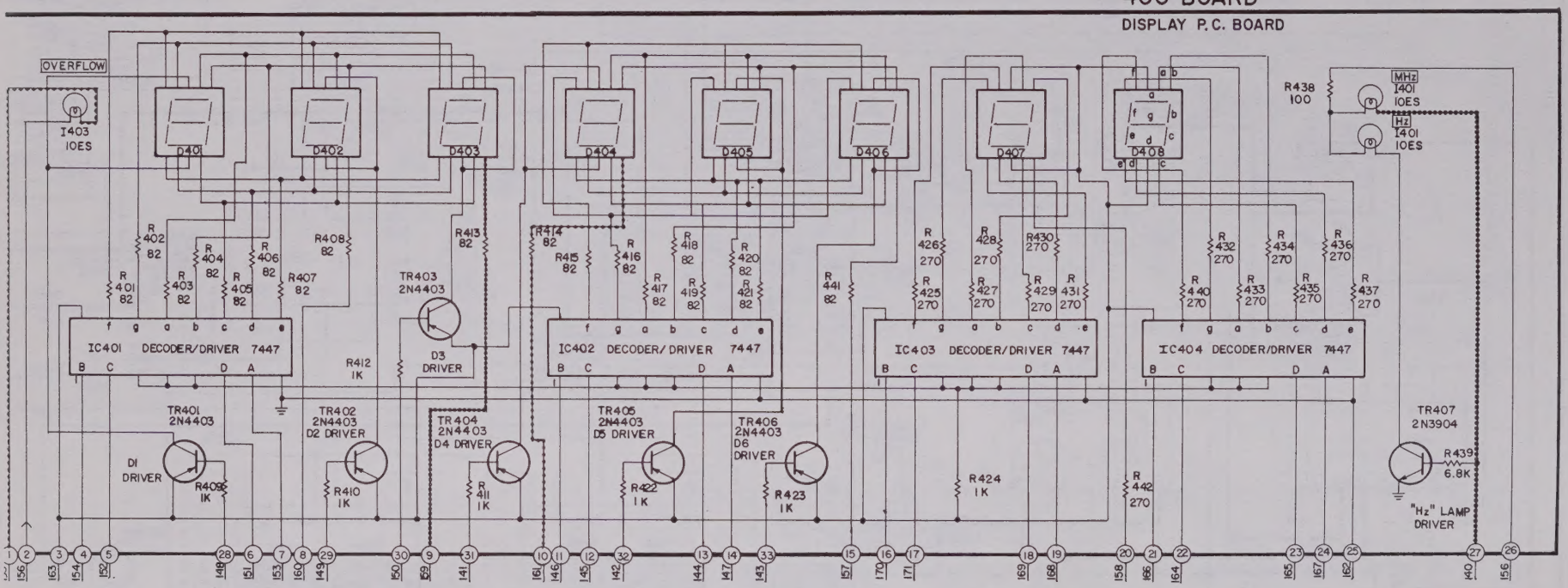


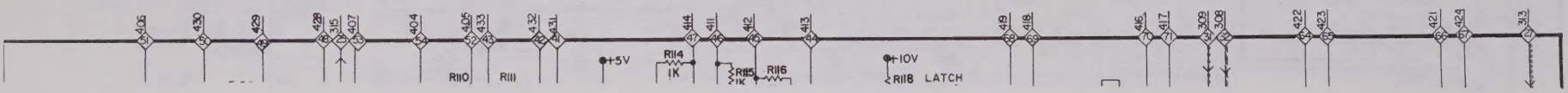

TRIPLE DECADE COUNTER
IC101 14553
TRIPLE DECADE COUNTER
IC102 14553
LATCH
IC103 74LS75
LATCH
IC104 74LS75
DECADE COUNTER
IC105 74LS90
LSD DECADE COUNTER
IC106 74S196
OVERFLOW LATCH
IC107 4013
INPUT SELECTORS
ECL/TTL TRANSLATOR
TTL/CMOS BUFFER
MPX BUFFER
O.F. LAMP DRIVER
O.F. BUFFER
BUFFER
GATE
RESET
ENABLE
MPX
INPUT SIGNAL
5V REG.
10 V REG.
LM324
MJE200
MJE180 6V REG.
2N4403
2N3904
2N5771
50 OHM
MEGOHM
XTAL
1 SEC
10 Hz-500Hz
500Hz-20 KHz
20 KHz-100 MHz
100 MHz-1 GHz
SWITCH POSITION KEY
IN
OUT
MAIN P.C. BOARD
100 BOARD



400 BOARD

DISPLAY P.C. BOARD

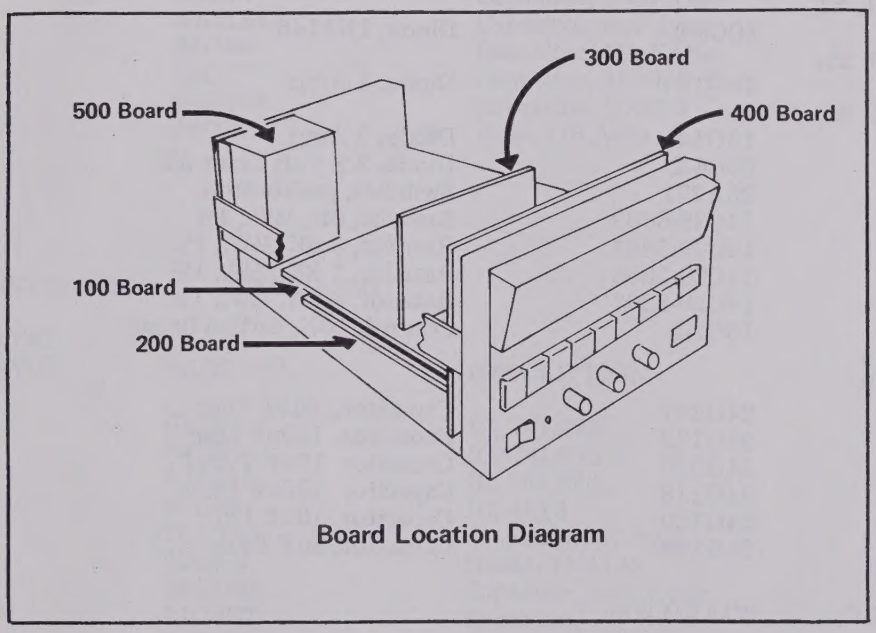




FC51

1GHz Frequency Counter

SCHEMATIC AND PARTS LIST
WITH "SIGNAL-TRACER" CODING



Board Location Diagram

THE ANALYZER PEOPLE

SENCORE

3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107 • (605) 339-0100

MAIN BOARD BOARD 100

SCHEMATIC REFERENCE	PART NO.	DESCRIPTION	PRICE
IC1, 2	69G23	IC, 14553	8.25
IC3, 4	69G41	IC, 74LS75	1.25
IC5	69G42	IC, 74LS90	1.25
IC6	69G54	IC, 74S196	4.25
IC7	69G8	IC, 4013	1.00
IC8	69G40	IC, 10211	3.75
IC9	69G39	IC, 10216	3.25
IC10	69G33	IC, 74500	1.00
IC11	69G13	IC, LM324	3.25
TR1, 2, 3, 4, 5, 6, 7, 11, 14, 15	19A33-1	Transistor, 2N3904	.50
TR8, 9	19A45	Transistor, 2N5771	1.00
TR10	19A39	Transistor, MJE200	2.25
TR12	19A40	Transistor, 2N4403	.75
TR13	19A29	Transistor, MJE180	1.25
CR1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 31, 32, 33, 34	50C5-2	Diode, 1N4148	.25
CR17, 19, 20, 25, 26, 27, 28, 29	16G10	Diode, 1 Amp	.50
CR18, 21, 22, 23, 24	16G14	Diode, 3 Amp	.50
CR30	50C4-2	Diode, 8.2 Volt zener 5%	.75
SW1	25A271	Switches, pushbutton	10.75
R58	14C29-6003	Resistor, 6K, ½W., 1%	.75
R59	14C29-3903	Resistor, 3.9K, ½W., 1%	.75
R62	14C29-1803	Resistor, 1.8K, ½W., 1%	.75
R63	14C29-8203	Resistor, 8.2K, ½W., 1%	.75
R70	15C7-2	Control, 10K, carbon linear	1.25
C1, 2, 3, 7, 13, 14, 15, 16, 17, 18, 21	24G207	Capacitor, .01uF Disc	.25
C4, 5	24G123	Capacitor, 720pF Disc	.25
C6, 8	24G333	Capacitor, 10uF TANT	.50
C9, 19	24G118	Capacitor, 100uF Lytic	.50
C10, 12, 20	24G120	Capacitor, 10uF Lytic	.25
C11	24G190	Capacitor, 2uF Lytic	.25

INPUT BOARD BOARD 200

SCHEMATIC REFERENCE	PART NO.	DESCRIPTION	PRICE
IC1	69G32	IC, 4046	2.25
IC2	69G11	IC, 4016	1.25
IC3	69G46	IC, TL084	5.25
IC4	69G7	IC, 4001	.75
IC5	69G36	IC, 4518	2.50
IC6	69G34	IC, 10114	1.75
IC7	69G49	IC, GPD402	26.00
IC8	69G48	IC, 8665	60.00
IC9	69G39	IC, 10216	3.25
TR1, 5, 6	19A33-1	Transistor, 2N3904	.50
TR2, 4	19A19	Transistor, MPF102	.75
TR3	19A7-1	Transistor, 2N3563	.50
CR1, 4, 5	50C5-2	Diode, 1N4148	.25
CR2, 3, 6	50A14	Diode, MBD502	2.25
R1, 2	14C29-1005	Resistor, 100K, ½W., 1%	.75
R8	14C29-1006	Resistor, 1M, ½W., 1%	.75

INPUT BOARD BOARD 200

R13, 14	14C29-2006	Resistor, 2M, ½W., 1%	1.00
R27, 50	15C7-17	Control, 1K, carbon linear	1.25
R72	15C7-7	Control, 5M, carbon linear	1.25
L1	46G72	Inductor, 680uH	.50
L2	46G9	Inductor, 10MH	1.25
C1, 9, 12, 14, 17, 19, 21, 23, 26, 28, 33, 37, 40, 50, 51, 52, 54, 55	24G207	Capacitor, .01uF Disc	.25
C2, 5	24G334	Capacitor, 2.2uF TANT	.50
C3	24G279	Capacitor, 470pF Polycap	.25
C4	24G345	Capacitor, 220pF Polycap	.25
C6, 8	24G104	Capacitor, .1uF Disc	.50
C7	24G22	Capacitor, 330pF Disc	.25
C10, 16	24G212	Capacitor, .047uF Mylar	.25
C11, 30, 35, 36	24G15	Capacitor, 100pF Disc	.25
C13, 15, 18, 20, 22, 24, 34, 38, 41, 53	24G333	Capacitor, 10uF TANT	.50
C25	24G77	Capacitor, 20pF Disc	.25
C27	24G154	Capacitor, 6pF Disc	.25
C29	24G86	Capacitor, 10pF Disc	.25
C31, 39	24G17	Capacitor, 1000pF Disc	.25
C32	24G368	Capacitor, 1000pF Ceramic	5.00
F1, 2, 3	44G21	Fuse, 1/8 Amp	1.25

TIMEBASE BOARD BOARD 300

SCHEMATIC REFERENCE	PART NO.	DESCRIPTION	PRICE
IC1, 2	69G31	IC, 74LS74	1.25
IC3	69G37	IC, 74LS00	.50
IC4, 7, 8	69542	IC, 74LS90	1.25
IC5, 6	69G36	IC, 4518	2.50
TR1, 2, 3	19A33-1	Transistor, 2N3904	.50
CR1	50C5-2	Diode, 1N4148	.25
C1	24G196	Capacitor, 2uF Lytic	.25
C2, 3, 4, 6	24G207	Capacitor, .01 Disc	.25
C5	24G15	Capacitor, 100pF Disc	.25
C7	24G17	Capacitor, .001 Disc	.25

DISPLAY BOARD BOARD 400

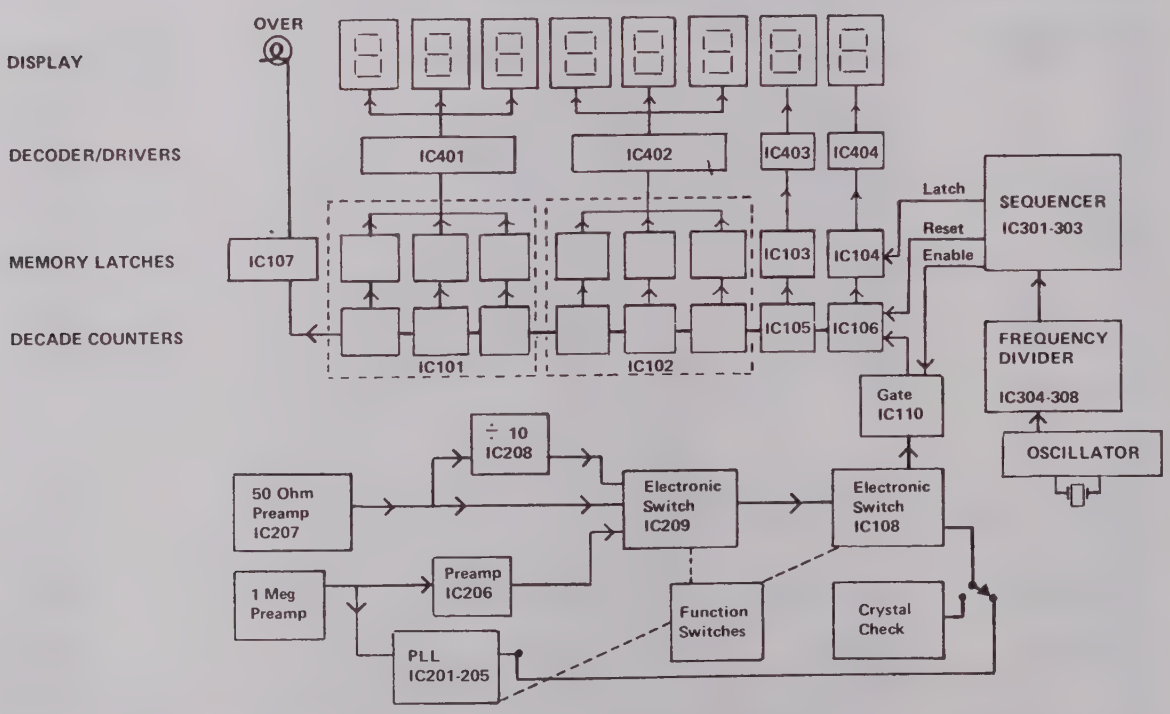
SCHEMATIC REFERENCE	PART NO.	DESCRIPTION	PRICE
IC1, 2, 3, 4	69G35	IC, 7447	2.00
IR1, 2, 3, 4, 5, 6	19A40	Transistor, 2N4403	.75
TR7	19A33-1	Transistor, 2N3904	.50
D1, 2, 3, 4, 5, 6, 7, 8	23G63	LED display	2.25
I1, 2, 3	20G15	10ES, bulb	1.00

continued

OSCILLATOR BOARD BOARD 500

SCHEMATIC REFERENCE	PART NO.	DESCRIPTION	PRICE
IC1	69G21	IC, CA3130	3.00
IC2	69G55	IC, LM375	12.00
IC3	69G52	IC, AD590K	20.00
TR1	19A33-1	Transistor, 2N3904	.50
TR2	19A29	Transistor, MJE180	1.50
CR1	50C12-1	Diode, 1N823	1.75
R2	14C29-1875	Resistor, 187K, ½W., 1%	.75
R3	15A19-4	Control, 100K, Ceramic	2.75
R4	14C29-2335	Resistor, 233K, ½W., 1%	.75
R6	14C29-1004	Resistor, 10K, ½W., 1%	.75
Y1	47A24-SEL2	10 MHz crystal	25.00
L1	46G72	Inductor, 680uH	.50
C1	24G90	Capacitor, 68pF Disc	.25
C2, 4, 5, 10, 12, 14	24G207	Capacitor, .01uF	.25
C3	24G72	Capacitor, 4pF Disc	.25
C6	24G162	Capacitor, 62pF Disc	.25
C7	24G157	Capacitor, 25pF Disc	.25
C8		Factory selected to match crystal	
	24G153	5pF	.25
	24G86	10pF	.25
	24G85	15pF	.25
C9	24K369	Trimmer, 1—6pF	.75
C11, 16	24G333	Capacitor, 10uF TANT	.50
C13	24G334	Capacitor, 2uF TANT	.50

FC51 Block Diagram



Components not listed are standard replacement parts and may be purchased locally. When ordering parts, please specify instrument model number, schematic reference, part number, and description. Please include remittance (check or money order) with your order, otherwise invoice will be shipped C.O.D. Minimum billing is $3.00. Prices and specifications in effect at date of printing and are subject to change without notice.

FC51

1GHz Frequency Counter

Operation, Application and Maintenance Manual

SENCORE
3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

TABLE OF CONTENTS

SAFETY WARNINGS ..... Inside Front Cover

DESCRIPTION
- Features 4
- Specifications 4
- Controls 6

OPERATION
- Power Connections 8
- Fuse Replacement 8
- Signal Connections 9
  - Supplied Counter Probe 9
    - 1 Meg Input, Direct Connection 10
    - 1 Meg Input, Isolated Connection 10
    - 50 Ohm Input, Direct Connection 10
    - 50 Ohm Input, Isolated Connection 10
  - 39G138 RF Pick-Up Loop 10
  - Using the 39G138 with Transmitters Over 100 Watts 11
  - Using the AN210 Antenna 11
- Selecting Proper Input 13
  - 50 Ohm Input 13
  - 1 Meg Input and Sensitivity Adjust 13
  - Crystal Check 14
- Selecting Frequency Range 14
- Selecting Read Rate 16
- Increasing Input Sensitivity with (Optional) WBA52 16
- 10 MHz Reference Output 18
- Timebase Module 19

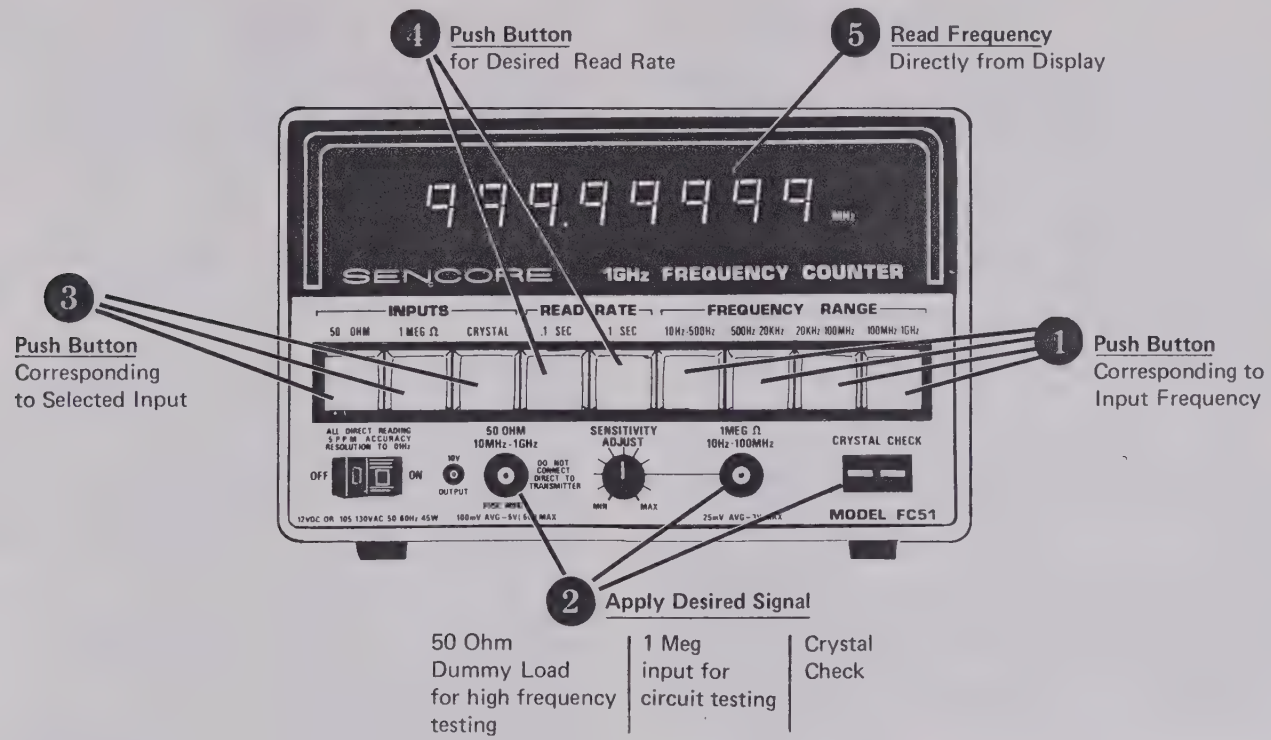
APPLICATIONS
- AM Modulated Signals 20
- FM Modulated Signals 20
- Noisy Signals 20
- Distorted Signals 21
- Extra Signals 21
- Digital Noise 22
- Pulse Ringing 22

MAINTENANCE
- Verifying Counter Accuracy 23
- Access/Disassembly 23
- 10 MHz Clock and Oven Module Replacement 24
- Recalibration Procedures 24
  - Timebase Module 25
  - Sensitivity Adjustments and Testing 26

SERVICE AND WARRANTY ..... Inside Back Cover

SIMPLIFIED OPERATIONS

Refer to Table of Contents for location of complete information.



SIGNAL CONNECTION SELECTOR GUIDE

FREQUENCY RANGE	10 Hz - 100 MHz		10 MHz - 1 GHz		10 Hz - 1 GHz	
	1 MEG		50 OHM		Pick-up	
SIGNAL SOURCE	Direct	Isolated	Direct	Isolated	Loop	Antenna
Audio Circuits	✓					
Digital Pulses		✓	✓ (ECL)			
Digital Square Wave Signals	✓		✓ (ECL)			
High Voltage Signals					✓	
IF Stages		✓			✓	
RF Oscillators (transmit or receive)		✓			✓	
RF Signal Generators			✓			
Signal Tracing	✓	✓			✓	
Transmitter Outputs					✓	✓

WARNINGS

1. Always replace fuses with correct value. Improper fuse(s) voids warranty.
2. Refer to specifications for maximum 1 Meg input and 50 Ohm input voltage.

DESCRIPTION

INTRODUCTION

Most electronics technicians are finding more and more need for a high accuracy digital frequency counter. Communications shops and commercial broadcast stations need both a wide frequency range and high accuracy in their frequency counters to meet the FCC requirements for accurate measurements of various transmitter frequencies. Service technicians find that a frequency counter is a valuable piece of test equipment for troubleshooting the digital circuits found in UHF and VHF television tuners and the modern digital FM receivers. Other applications (like video tape recorder, medical equipment, and industrial maintenance) require frequency counters for many tests and adjustments.

The FC51 offers both a wide input frequency range and high accuracy for work in any of these applications where the signal is between 10 Hz and 1000 MHz. Extra features, like all pushbutton operation and automatic selection of prescalers, are normally found only on frequency counters costing much more than the FC51. A review of the following section will cover these special features and explain how they simplify the operation of the FC51 and offer versatility not usually found in a frequency counter in this price range.

FEATURES

The FC51 1 GHz Frequency Counter allows direct readings of all frequencies from 10 Hz through 1 GHz with accuracies that exceed the FCC specifications for all communications work up to 1 GHz. The metal case of the FC51, along with internal RF shielding, provides interference-free measurements in practically any type of RF field.

The large (.5") 8-digit display allows direct readings with automatic placement of the decimal. Special indicator lights show whether the counter is measuring "Hz", or "MHz", and an overflow indicator indicates that a reading requires more than the full 8 digits of readout.

The FC51 features large, comfort-sized pushbuttons for ease of operation. These buttons select the desired input jack, read rate, and frequency range. Three inputs are available. The first is a fuse-protected 50 Ohm termination for proper reading of high frequency signals. The 50 Ohm termination prevents cable ringing which could cause inaccurate readings.

The second input is a high sensitivity input with 1 Megohm loading to allow direct connections to lower frequency circuits. This input is controlled by a front-panel sensitivity control which allows many noisy signals to be measured which normally will produce erratic readings on a high sensitivity counter.

The sensitivities of both of these inputs have been designed for fast signal tracing in most applications. If additional sensitivity is required for special applications, the optional WBA52 1 MHz through 1 GHz Wideband Amplifier provides an additional 30 dB of input gain. The WBA52 is powered from the accessory jack on the front of the FC51.

The third input is Sencore's exclusive crystal check which allows any crystal to be tested by simply inserting it into the special front panel test socket.

Two read rates give a choice of fast updates or maximum resolution, depending on the type of signal you want to measure. Four different frequency range buttons provide the best resolution for any measurement. Two built-in prescalers extend both the high and low frequency capabilities of the FC51. The first prescaler allows frequencies from 100 MHz to 1 GHz to be measured and the second "audio prescaler" provides additional digits of resolution when measuring frequencies below 20 KHz. Both prescaled options provide automatic decimal placement for direct readings.

The high accuracy timebase oscillator is built into a proportionally-controlled oven to assure the high accuracy possible over a wide range of ambient temperatures. The entire oven and oscillator is contained in a single plug-in module to allow the option of exchanging the module with one that is freshly calibrated so that it is not necessary to return the entire counter for accuracy calibration.

Finally, the FC51 offers a choice of 110-120 VAC line operation or 12 VDC operation for versatility of use in bench or portable testing. Input connections are made with the supplied counter probe, pickup loop or adjustable antenna.

SPECIFICATIONS

INPUTS:

Frequency Range

1 Megohm Input

10 Hz — 100 MHz

50 Ohm Input

10 MHz — 1000 MHz

50 Ohm VSWR: Lower than 2.5:1 through 1 GHz

CRYSTAL CHECK

1 — 20 MHz Fundamental Frequency

(Overtone crystals read at approximately fundamental frequency.)

ACCURACY

$\pm$ Timebase accuracy $\pm$ 1 digit

TIMEBASE (replaceable module)

Crystal Frequency: 10 MHz—proportional oven-controlled

Setability: ± 0.01 ppm (.000001%)

Temperature Stability: 0.5 ppm (.00005%), 0—40° C. Ambient after 10 minute warmup

Maximum aging: 2 ppm/year

Timebase output available through rear panel BNC jack.

Recommended recalibration interval: 1 year for FCC tolerances below 800 MHz, 6 months for frequencies above 800 MHz.

MAXIMUM RESOLUTION

10 — 500 Hz
.01 Hz
500 — 20000 Hz
.1 Hz
20 KHz — 100 MHz
1 Hz
100 — 1000 MHz
10 Hz

READ RATES (gate times)

1 second or .1 second
Pushbutton selected.

SENSITIVITY

1 Megohm Input
10 mV typical to 20 MHz
25 mV average when sensitivity control is at maximum — continuously variable to cut-off (See response curve.)

50 Ohm Input
100 mV average
3 mV average with WBA52
(See response curve.)

INPUT PROTECTION

1 Megohm Input
250 V pp to 10 KHz
50 V pp to 30 MHz
8 V pp to 100 MHz

50 Ohm Input
5 Volts RF, fuse-protected
100 Volts DC max.

GENERAL

DISPLAY: 8 digit, 0.5" LED, auto decimal, overflow, "Hz" and "MHz" indicators.

SIZE: 5.5" x 7.83" x 9" HWD (14 cm x 19.9 x 22.9 cm)

WEIGHT: 6.5 lbs. (2.9 Kg)

POWER: 105—130 VAC, 50/60 Hz, 45 W max. (220 VAC conversion available) 12 VDC, 2.2 Amps maximum

FUSE REQUIREMENTS: 1/8 Amp RF fuse for 50 Ohm input, 2 spare fuses included on P.C. board. 3 Amp, 3AG Fastblow for 12 VDC leads. One spare fuse included.

AC LINE: Transformer internally fused.

ACCESSORY OUTPUT VOLTAGE: 9—12 VDC through the front panel jack to power WBA52 1 GHz Amplifier.

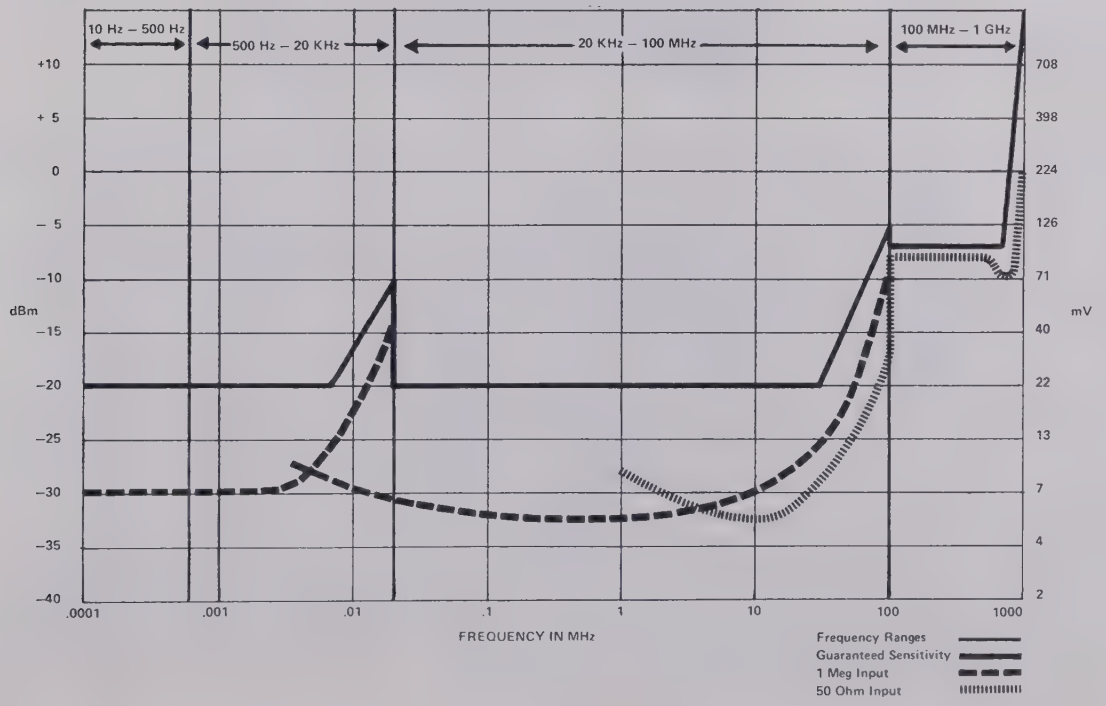
ACCESSORIES

Supplied: 39G112 Direct/isolated Counter Probe
39G111 Fused DC Supply Lead
39G138 RF Pick-up Loop and extension
AN210 Antenna

Optional: WBA52 1 GHz Wideband Amplifier

Specifications subject to change without notice.

GRAPH 1 — Guaranteed and typical sensitivity curves for FC51.



CONTROLS

1. **LED readout, 8-digit** with automatic placement of decimal for all readings.

2. **Overflow indicator,** which shows when reading exceeds 99.999999 or 999.99999 MHz.

3. **Vinyl-clad steel case,** provides full RF shielding for stable readings.

INPUT SELECTOR BUTTONS

4. **Crystal check input button** for testing crystals inserted into socket (15).

5. **1 Megohm input button** selects high sensitivity input jack (14) for measuring frequencies up to 100 MHz.

6. **50 Ohm input button** selects high frequency input jack (11) for proper termination of higher input signals. Operating range 10 MHz—1 GHz.

7. **Handle/tilt stand** for portable applications or for tilting unit on bench.

8. **Power switch,** controls unit when operated from AC or DC inputs.

9. **10 Volt accessory jack** for powering WBA52 1 GHz Wideband Amplifier or other accessories. Ground return is through shield of input jack.

10. **50 Ohm input jack** provides proper termination for 50 Ohm coaxial cable to prevent double counting due to reflections. RF protection fuse is located inside unit along with two spare fuses.

READ RATE BUTTONS

11. **.1 second read rate** provides approximately 10 readings per second for fast updates when maximum resolution is not necessary.

12. **1 second read rate** provides approximately 1 reading per second for one extra digit of resolution and for more stable reading of "drifty" signals.

13. **Sensitivity adjust control** operates in conjunction with 1 Megohm input jack (14) to provide variable sensitivity for measuring signals with noise information.

14. **1 Megohm input jack** provides high sensitivity for direct signal connections.

15. **Crystal check socket** provides universal socket for testing crystals out of circuit.

FREQUENCY RANGE BUTTONS

16. **10 Hz—500 Hz range button** provides internal resolution multiplier to produce .01 Hz resolution with a 1 second read rate. Used only with 1 Megohm input jack (14).

17. **500 Hz—20 KHz range button** provides internal resolution multiplier to produce .1 Hz resolution with a 1 second read rate. Used only with 1 Megohm input jack (14).

18. **20 KHz—100 MHz range button** provides a direct (non-prescaled) input for direct counting to 100 MHz. Works with either input jack (11 or 14).

19. **100 MHz—1 GHz range button** provides a 10:1 prescaled input with automatic decimal placement. Should be used only with 50 Ohm input jack (11).

20. **MHz range light** used with automatic decimal for direct readout of frequency.

21. **Hz range light** used with automatic decimal for direct readout of frequency.

REAR PANEL

22. **Timebase output jack** provides a buffered output of the 10 MHz reference oscillator for checking accuracy with another frequency standard or for calibrating other less accurate counters.

23. **Antenna clips** for storing AN210 antenna.

24. **Spare fuse clip** for storing a spare 3 Amp fuse for use in the DC supply leads.

25. **AC input line cord.**

26. **DC input jack** for supplying 12 VDC (negative ground) for portable operation of counter.

27. **Cord wrappers** for storing AC line cord and test leads.

SUPPLIED ACCESSORIES

28. **AN210 Adjustable Antenna** for picking up off-the-air signals.

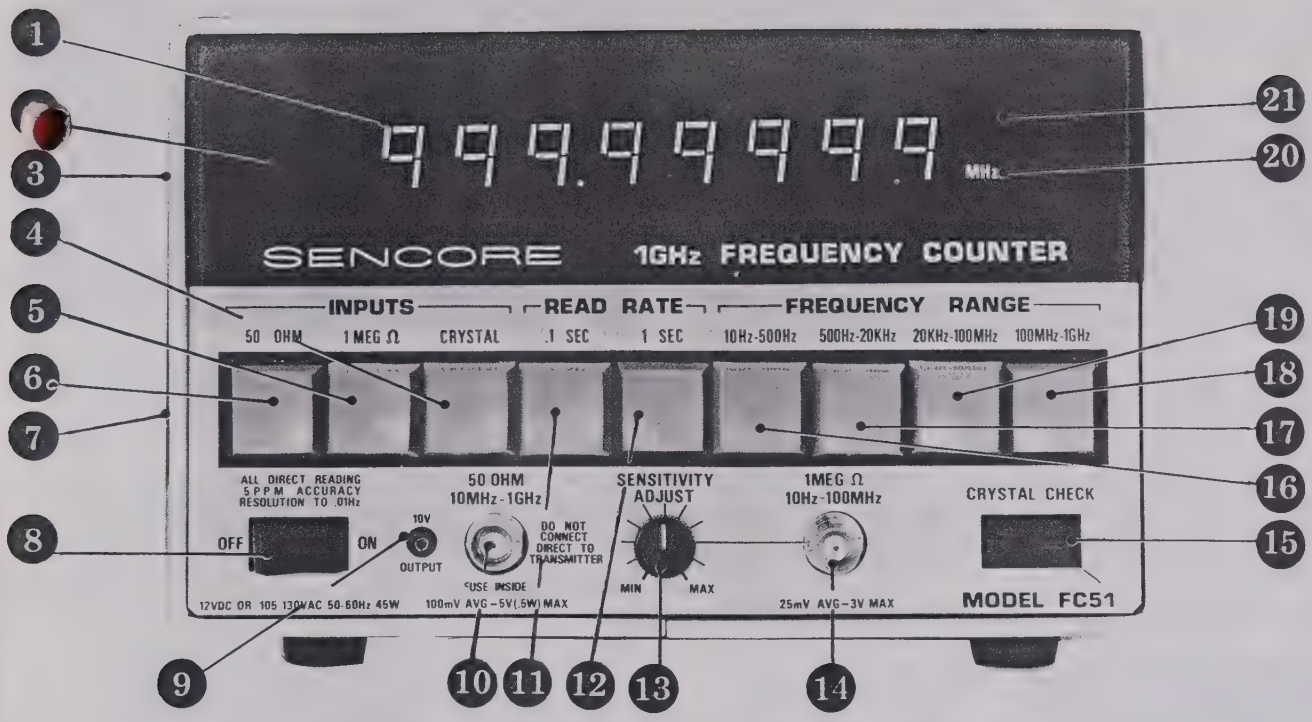
29. **39G112 Counter Probe** with direct/isolate switch for use when direct connection is desired.

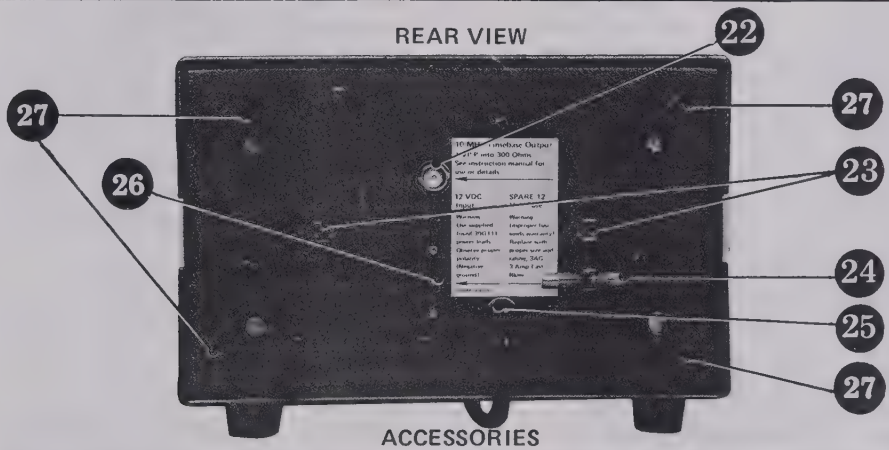
30. **39G111 Fused DC Supply Leads** for powering FC51 from auto accessory jack.

31. **39G138 RF Pick-up Loop** for making high frequency or high power frequency measurements when a direct connection is not desired.

OPTIONAL ACCESSORY

32. **WBA52 1 GHz Wideband Amplifier** to increase input sensitivity of either 50 Ohm or 1 Megohm inputs for measuring extremely small signals. Powered from 10 Volt accessory jack (9) on FC51.





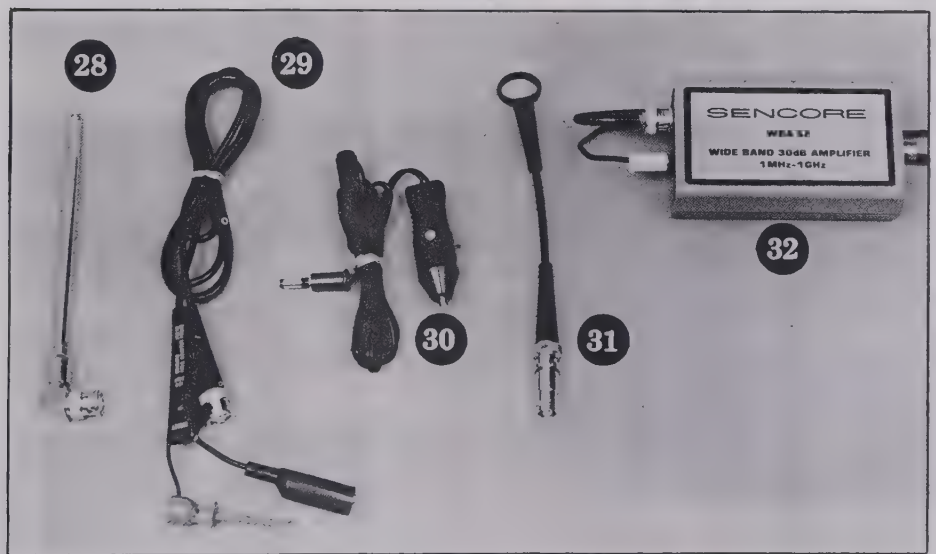


Fig. 1—Location of controls and features.

OPERATION

INTRODUCTION

Before using your FC51 for the first time, take a few minutes to read through the operations and applications section of the manual carefully to acquaint yourself with the features of the FC51. Once you are familiar with the general operations, most tests can be performed with the information provided on the FC51's front panel.

POWER CONNECTIONS

AC OPERATION: The FC51 is designed to be operated from 105-130 VAC (50/60 Hz). If 210-230 VAC operation is required, the unit may be modified (at additional cost) by the Sencore Service Department, 3200 Sencore Drive, Sioux Falls, SD 57107.

To operate the FC51 from a standard AC line:

1. Connect the AC cord to a 117 VAC (or 220 VAC for modified units) outlet.

2. Turn the power switch on.

3. The FC51 is immediately ready for frequency measurements. If very precise measurements are to be made, the unit should be allowed to operate for at least ten minutes to allow the temperature of the crystal oven to stabilize.

DC OPERATION: The FC51 may be operated from a 12 VDC power source capable of delivering 2.2 Amperes. Power is supplied through the standard adapter jack located at the bottom of the rear panel. A set of fused DC supply leads is supplied with the FC51 for DC operation. Make sure the proper size fuse (see FUSE REPLACEMENT below) is in the in-line fuse holder for protection of your FC51 during DC operation.

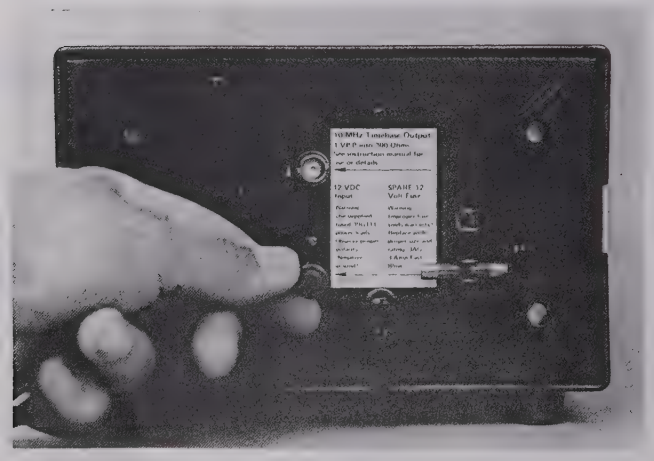


Fig. 2—Connecting the 12 Volt DC supply lead. Be sure to observe proper polarity (negative ground).

CAUTION

Observe proper polarities (negative ground) when connecting the DC power source. No damage will result if the polarity is reversed, but the FC51 will not operate with a reversed polarity.

To operate the FC51 from 12 Volts DC:

1. Connect the adapter plug of the supplied 39G111 DC power supply leads to the DC input jack on the back of the FC51.

2. Connect the standard automotive accessory plug of the supplied power supply leads to the source of 12 VDC, observing proper polarity.

3. Turn the power switch on.

4. The FC51 is immediately ready for frequency measurements. If very precise measurements are to be made, the unit should be allowed to operate for at least ten minutes to allow the temperature of the crystal oven to stabilize.

FUSE REPLACEMENT

WARNING

Always replace the fuses with the value specified. Larger value fuses may cause internal damage to the FC51 or cause a fire hazard and will void all warranties.

If the FC51 should fail to operate when connected to a 12 Volt DC power source, check the power supply fuse. If the fuse continues to blow each time it is replaced, refer to the service and maintenance section of the manual.

AC FUSE: The FC51 does not require an AC fuse as the transformer uses a special internally protected primary winding.

DC FUSE: The fuse for DC operation is located in the in-line fuse holder in the 39G111 power supply leads. Disconnect the power supply leads from the DC supply before removing the fuse. The fuse holder is opened by pushing slightly against the two sections of the fuse holder and twisting the two sections in opposite directions.

Replace the fuse with a 3 Amp Fastblow 3AG fuse only.

50 OHM INPUT FUSE: The 50 Ohm input is protected by a special RF fuse located inside the bottom cover on the input PC board of the FC51. Failure of the FC51 to stabilize and a lack of sensitivity through the 50 Ohm input indicates possible failure of the 50 Ohm input fuse.

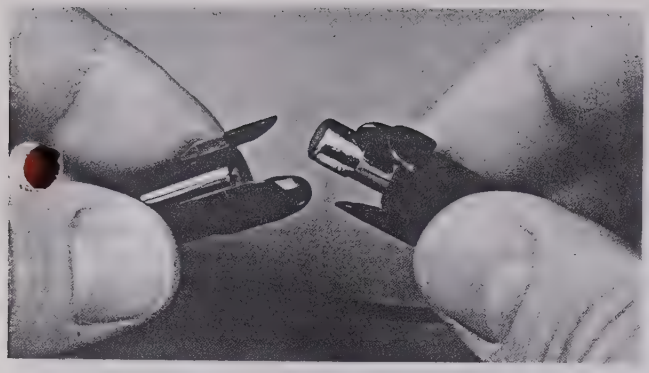


Fig. 3—The fuse in the 39G111 DC supply lead is changed by separating the two halves of the fuse holder.

The procedures for checking this fuse are as follows:

1. Connect one end of the supplied connector cable with a BNC connector on each end to the 10 MHz reference output jack located on the back of the FC51. Connect the other end of the cable to the 50 Ohm input jack.

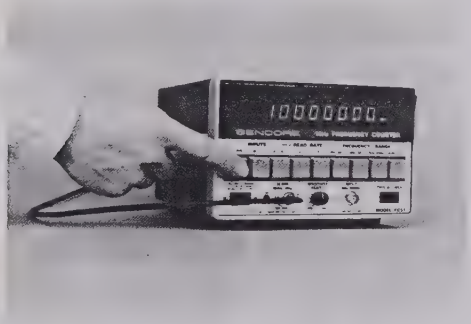


Fig. 4—The 10 MHz output (back panel) provides a convenient signal source for testing the 50 Ohm input fuse. The counter should read 10 MHz with good stability.

2. Depress the 50 OHM INPUT button and the 20 KHz to 100 MHz FREQUENCY RANGE button.

3. The counter should register 10.00000 MHz ± 1 count when the 1 SEC READ RATE button is depressed. Failure to obtain a correct reading indicates fuse failure. For fuse replacement instructions, refer to the maintenance section of this manual.

TABLE I – BLOWN FUSE CONDITIONS

FUSE	TYPE	CONDITIONS
DC Power	3 Amp 3AG Type	Unit will not turn on when DC-operated.
50 Ohm Input	1/8 Amp Micro-fuse	Loss of sensitivity at the 50 Ohm input. Unstable readings in 20 KHz–100 MHz and 100 MHz-1 GHz frequency ranges.

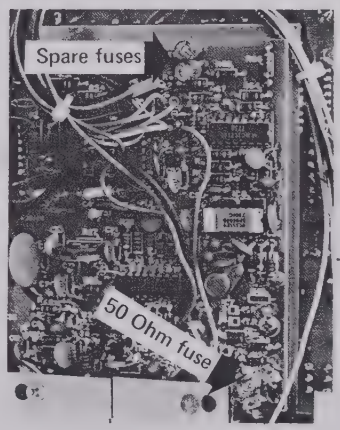


Fig. 5—Access to the 50 Ohm input fuse is obtained by removing the bottom panel. Two spare fuses are supplied. Be sure to disconnect the AC power cord before removing the bottom panel.

SIGNAL CONNECTIONS

Several methods may be used for measuring frequencies with the FC51. In many cases a direct connection to the circuit under test is desired. The 39G112 Frequency Counter Probe, supplied with the FC51, allows a direct or capacitively isolated connection. Other testing techniques require indirect or "loose" coupling to prevent the counter's input circuits from disturbing the circuit being measured—the 39G138 RF Pick-up Loop or the AN210 Antenna are intended to be used for this application.

USING THE SUPPLIED COUNTER PROBE

The supplied 39G112 Frequency Counter Probe allows direct or capacitively isolated input. The choice between these two inputs is made with a miniature slide switch built into the probe. The Frequency Counter probe may be used with the 1 MEG INPUT or the 50 OHM INPUT.

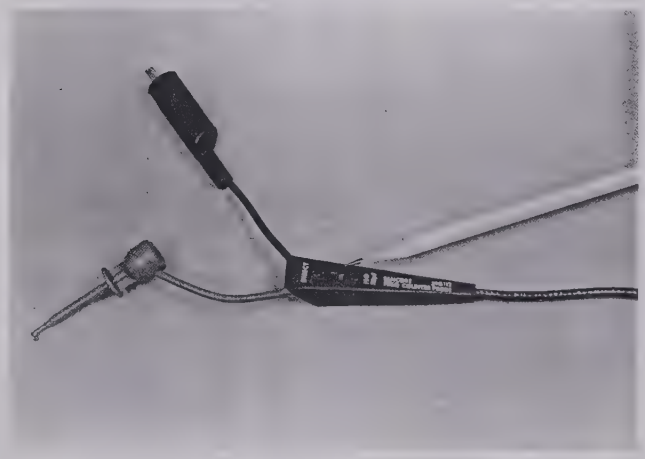


Fig. 6—Supplied 39G112 Counter Probe is equipped with a switch to select direct or isolated connections.

The following are guidelines as to when to use each option available with the 39G112 Frequency Counter Probe:

1 MEG INPUT, DIRECT CONNECTION
Generally, this connection is used for measuring frequencies that require a direct connection. The 1 Megohm loading of the FC51 input will not affect most circuits isolated from an oscillator by at least one amplifier (buffer) stage. This connection offers the highest counter sensitivity for measuring low-level signals. At frequencies above 10 MHz, the positioning of the ground connection may affect the stability of the reading. If an unstable reading is obtained at these higher frequencies, it can generally be made more stable by adjusting the input sensitivity control and/or moving the ground connections as close as possible to the test point being measured.

1 MEG INPUT, ISOLATED CONNECTION
The isolated switch position of the 39G112 Counter Probe inserts a 33 pF isolation capacitor in series with the test lead. This series capacitance reduces the capacitance formed by the cable running from the counter probe to the counter input. This isolation allows connecting the probe to many oscillators that become inoperative when a direct connection is made. As with the direct connection, the position of the ground connection may affect the stability of higher frequency measurements.

50 OHM INPUT, DIRECT CONNECTION
The 50 OHM INPUT prevents reflected signals on the 50 Ohm cable of the counter probe. This termination is especially important when measuring signals with fast transitions such as square waves or logic pulses from some digital circuits. The 50 Ohm termination prevents cable ringing which may occur due to the fast rise-time of these signals.

NOTE: The 50 Ohm input may load the output of some logic ICs. See "Special Digital Applications" for techniques that prevent this circuit loading.

50 OHM INPUT, ISOLATED CONNECTION
This option is generally not used because it offers no real advantage over the above connection. The input to the 50 Ohm input is AC-coupled to prevent DC circuit loading.

THE 39G138 RF PICK-UP LOOP

There are many times when a direct counter connection is not desired. Many oscillators used in communications equipment cannot be measured with a probe connected—even with the isolation capacitor in-circuit. The probe's capacitance may cause the frequency of the oscillator to change, or cause the oscillator to stop running, as the lead capacitance is placed in parallel with the oscillator circuit. Transmitters may have voltages exceeding the protection rating of the 1 Meg input and the 50 Ohm input. For these applications, an inductive pickup loop may be used to "sniff" the frequency without a direct connection eliminating interference with the measured circuit and, at the same time, providing input protection to the FC51 input circuits.

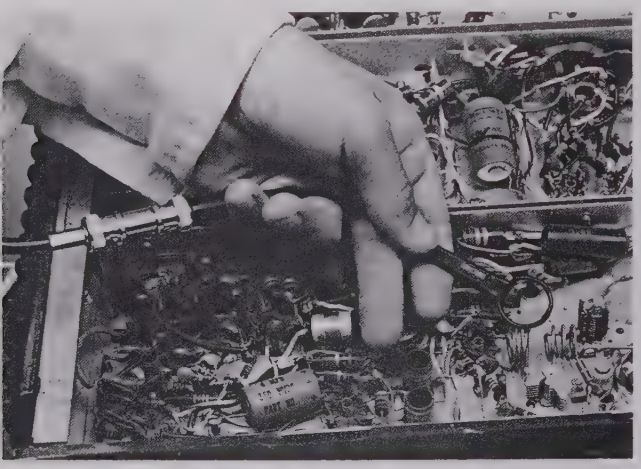


Fig. 7—The 39G138 pickup loop allows signals to be picked up without a direct connection. The supplied extension cable and "barrel" connector provide complete versatility in making connections.

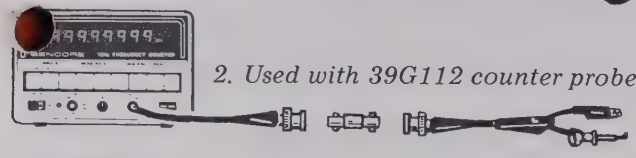
The 39G138 may be used with either the 50 Ohm or 1 Megohm input depending on the specific application. The 1 Megohm input provides better sensitivity at lower frequency ranges (generally 1—80 MHz). The 50 Ohm input, on the other hand, provides a termination which will make the 39G138 more effective at higher frequencies. The 50 Ohm input will also keep the amount of signal applied to the counter input lower, which makes it better suited for use in high power applications (over 50 Watts RF).

The 39G138 is supplied in three sections: 1.) The pick-up loop itself with a short coaxial cable stub, 2.) An extension cable with a BNC connector at both ends, and 3.) A BNC to BNC "barrel" to allow the two sections to be connected together. This allows many options for picking up signals in different locations.

When the 39G138 Pickup Loop is used with the FC51, the extension cable provides a convenient length for most signal tracing. When the 39G138 is used with the optional WBA52 1 GHz Wideband Amplifier, the 39G138 will generally be used without the extension. This allows the WBA52 to be used as a "handle" for holding onto the pickup loop during operation. The advantage to this is that the amount of cable length is kept to a minimum at the input to the high sensitivity amplifier to prevent noise pickup.

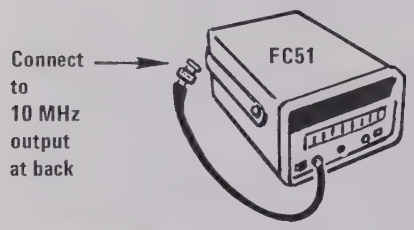
Additional uses of the extension cable will be found in testing with the supplied antenna (see "Using the

1. Used with 39G138 pickup loop.

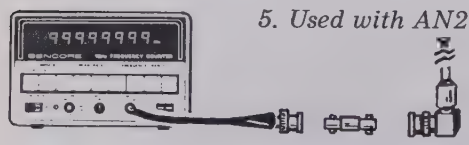


2. Used with 39G112 counter probe.

3. Used for testing generators with 100 mV output.



4. Used for testing 50 Ohm fuse.



5. Used with AN210 antenna.

Fig. 8—Uses of supplied cables.

AN210 Antenna") and for checking the 50 Ohm input fuse (see "Fuse Replacement").

To use the 39G138 Pick-up Loop:

1. Connect the 39G138 to the 1 Meg or 50 Ohm input of the FC51, using the extension cable.

2. Select the desired INPUT, READ RATE, and FREQUENCY RANGE buttons.

3. Place the pickup loop near a capacitor or coil in the circuit to be tested. If an unstable count is obtained, re-position the pickup loop as necessary to stabilize the count. If no count is obtained, turn the pickup loop over (which reverses the polarity of the pickup loop's coil) or select a different component in the circuit.

4. The pickup loop will work best when placed next to or around a coil. However, the high sensitivity of the FC51 will also allow signal pickup from capacitors, transistors, or crystals in most circuits.

ıe pickup loop may be used to trace a signal through ri stages of a circuit by placing the coil near each ıge. Generally, it is best to start with the signal urce (oscillator) and work towards the output stages ıen signal tracing.

USING THE 39G138 WITH TRANSMITTERS OVER 100 WATTS

The 39G138 may be used to measure the output frequency of extremely high-power transmitters. However, care should be used to prevent possible overload damage to the FC51 or a shock hazard to the operator. Always use the 50 Ohm input for these high power applications. The input protection fuse will provide additional input protection when making these measurements.

When measuring commercial AM, FM, or TV transmitter outputs, the RF pickup loop should be placed as far from the high-power output circuits as possible. Begin with the loop several inches from the signal to be measured, and then move the loop towards the output stage until a stable count is registered. If the transmitter is provided with a sampler circuit which samples the RF signal and provides a low-level output, this connection should be used for frequency counter connections.

USING THE AN210 ANTENNA

It is often desirable to be able to make frequency tests without the need of removing any of the covers of a transmitter, or to test the transmitter frequency without removing it from service. Examples of this type of measurement are: 1.) Testing the output frequency of a walkie-talkie, 2.) Testing a repeater transmitter which cannot be removed from service without causing down-time which would put the repeater users out of radio contact, 3.) Testing a commercial AM, FM, or TV station which may otherwise require that the transmitter be turned off, 4.) Measuring the frequency of a mobile transmitter by simply driving up next to the transmitter and testing the frequency without the need of pulling an otherwise good transmitter from service. Each of these applications is best served with the use of the AN210 Frequency Counter Antenna.

Fig. 9—The AN210 antenna allows measurements of off-the-air signals for such applications as testing walkie-talkies. The length of the AN210 should be adjusted for best sensitivity.

The AN210 is adjustable so that it can be tuned to various frequencies for maximum sensitivity. The AN210 can be used with either the 50 Ohm or the 1 Megohm input, but is generally used with the 50 Ohm input for measurements above 90 MHz. The accompanying graph shows the optimum length for each frequency to be measured. Begin by setting the length of the AN210 to the length shown in the graph for these higher frequencies. Frequencies below 90 MHz should be measured with the antenna fully extended. If a stable count below 90 MHz is not possible with the antenna connected to the 50 Ohm input, move it to the 1 Megohm input and adjust the antenna for the most stable reading.

The best sensitivity is possible with the antenna of the transmitter as close as possible to the AN210. A 2 Watt walkie-talkie, for example, can usually be measured for a distance up to 20 feet away from the counter antenna. Additional sensitivity provided by the optional WBA52 1 GHz Wideband Amplifier allows the use of the AN210 for special applications requiring greater distances such as portable testing of mobile transmitters.

It is sometimes desirable to have the antenna some distance from the counter. This is especially true when used in mobile applications. Simply use the extension cable and barrel supplied with the 39G138 Pickup Loop as an antenna extension.

To use the AN210 Antenna with the FC51:

1. Locate the frequency counter near the source of RF signals. The optimum distance will depend on the specific frequency being measured and the output power of the transmitter.

2. Connect the antenna to the desired input using the guidelines covered above.

3. Select the proper INPUT, READ RATE, and FREQUENCY RANGE buttons.

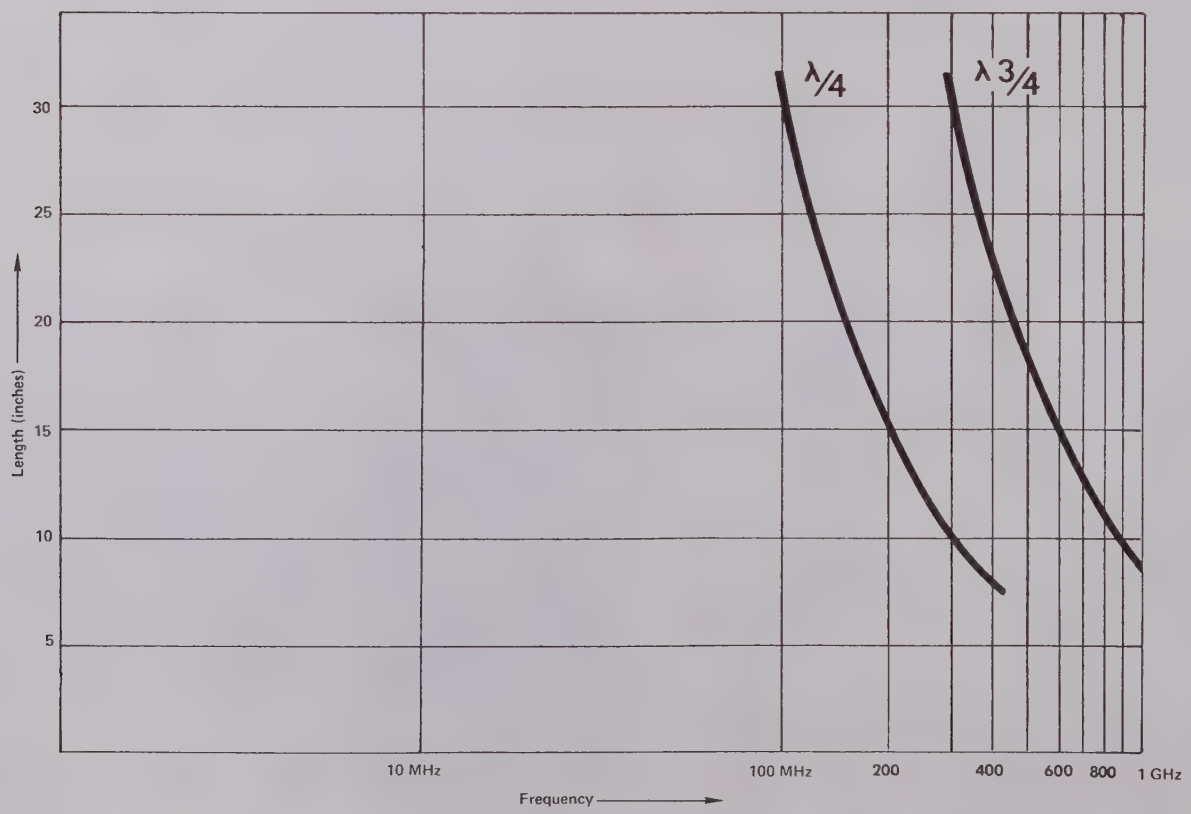
4. Adjust the antenna length for the most stable readings. Refer to graph II for the proper antenna length for frequencies above 90 MHz. If the reading is not stable, readjust the antenna length or re-position the transmitter.

5. Read the resulting frequency.

NOTE: High levels of modulation (either AM or FM) may cause some instability in the readings. If such instabilities are present, the modulation should be reduced or removed until the frequency measurement is complete. See the "Applications" section of this manual for details on measuring modulated frequencies.

If you need to measure frequencies at greater distances, the WBA52 should be used. See "Using the WBA52" section of this manual for details.

GRAPH 2 — Proper antenna length for best sensitivity.



SELECTING PROPER INPUT

The FC51 offers three counter inputs: A 50 Ohm input, a 1 Megohm adjustable sensitivity input, and a crystal check input. The following instructions cover each input:

50 OHM INPUT

WARNING

The maximum input the 50 Ohm input can safely dissipate is .5 Watts. Higher input power will cause the 50 OHM INPUT protection fuse to blow. The maximum DC voltage that can safely be connected to the 50 Ohm input is 100 Volts.

The 50 OHM INPUT is designed to be used with either the 39G138 RF pickup loop or the AN210 adjustable antenna for measuring signals within the 10 MHz to 1 GHz range. For details on using either the 39G138 PICKUP LOOP or the AN210 ANTENNA, refer to the "SIGNAL CONNECTION" section of this manual.

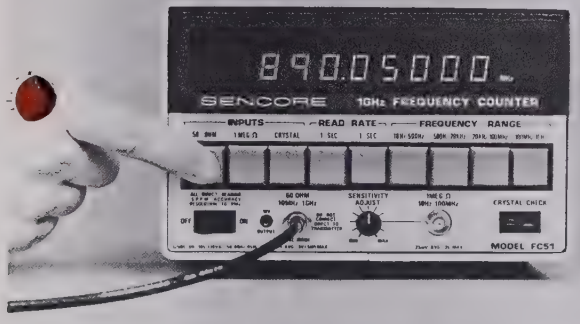


Fig. 10—The 50 Ohm input is generally used with the 39G138 RF pickup loop or AN210 antenna for measuring high frequencies.

To use the 50 Ohm input:

1. Connect the desired signal to the 50 Ohm input jack. See "Signal Connections" for details.

2. Depress the 50 OHM INPUT button on the front panel.

3. Select the desired READ RATE and FREQUENCY RANGE buttons as described in the following sections.

Read the resulting frequency on the digital readout.

1 MEG INPUT AND SENSITIVITY ADJUST

WARNING

The 1 Meg load is protected against overload, but the amount of protection changes with input frequency. Do not apply more input signal than listed in the table below or possible damage to the input preamplifier may result. Such overload is not covered by Sencore's 90-Day Warranty or 100% Made Right Lifetime Guarantee.

TABLE II – OVERLOAD PROTECTION

FREQUENCY RANGE	MAXIMUM INPUT VOLTAGE
10 Hz - 10 KHz	250 VP-P
10 KHz - 30 MHz	50 VP-P
30 MHz - 100 MHz	8 VP-P (3V RMS)

The maximum DC bias signal that may be applied is 250 Volts.

The 1 MEG INPUT is designed to accept signals within the 10 Hz to 100 MHz range. The connection to this input is usually made with the 39G112 Counter Probe. A slide switch, on the probe, selects either a direct or an isolated input. For details concerning the use of this probe, refer to the "USING SUPPLIED PROBE" section under "SIGNAL CONNECTIONS".

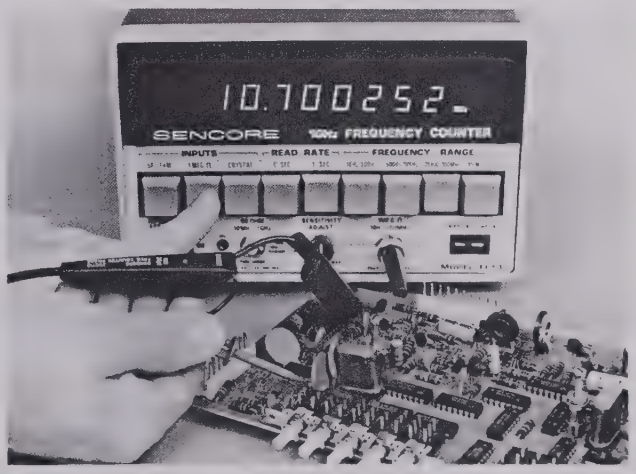


Fig. 11—The 1 Megohm input is used with the supplied 39G112 counter probe or 39G138 RF pickup loop for measuring frequencies from 10 Hz through 100 MHz.

Complex waveforms often present difficulty in measurement. The frequency counter will respond to all of the frequencies and may have an unstable reading. The Sensitivity Adjustment reduces the sensitivity of the 1 MEG INPUT so that it responds only to the largest amplitude signal.

To use the 1 Meg input and the sensitivity adjustment:

1. Connect the desired signal to the 1 MEG INPUT jack. See "SIGNAL CONNECTIONS" for details.

2. Set the SENSITIVITY ADJUSTMENT to maximum. Note: This is its "normal" position for most measurements.

3. Depress the 1 MEG INPUT button. Select the desired READ RATE and FREQUENCY RANGE buttons as described in the following sections.

4. Read the resulting frequency on the Digital Readout. An unstable or incorrect readout may be corrected as follows:

A. Gradually reduce the sensitivity with the sensitivity adjustment control until the digits lock in.

B. Read the resulting frequency.

CRYSTAL CHECK

The CRYSTAL CHECK function allows any crystal with a fundamental frequency of 1—20 MHz to be inserted into the front panel universal crystal socket to check for crystal activity. The crystal will be made to resonate at its fundamental operating frequency.

NOTE: Most crystals used in communications equipment are designed to operate on an overtone rather than their fundamental frequency. For example, an oscillator operating at 27.000 MHz will use a third overtone crystal with a fundamental frequency of 9.000 MHz. In practice, there are few, if any, crystals with a fundamental frequency of over 20 MHz. The exact operating frequency of the crystal depends on the circuit of which it is part. Measurement of the exact operating frequency of the crystal is only possible by measuring the output of the circuit in which it is operating.

To perform the external CRYSTAL CHECK:

1. Insert the crystal to be tested into the front panel socket marked CRYSTAL CHECK.

2. Select either the .1S or 1S READ RATE button.

3. Depress the 20 KHz—100 MHz frequency range button.

4. Depress the CRYSTAL CHECK button.

5. Read the fundamental crystal frequency on the digital readout.

Defective or inoperative crystals will be indicated by an intermittent or zero readout.

Fig. 12—The crystal check reads approximately the fundamental frequency of the crystal inserted into the test socket. This fifth overtone crystal normally operates at 55.160 MHz.

SELECTING FREQUENCY RANGE

The four frequency range buttons of the FC51 offer three different methods of input signal conditioning which are automatically selected by the FREQUENCY RANGE buttons. Audio frequencies (10 Hz—20 KHz) are automatically routed through a "resolution multiplier" circuit which allows an increased number of digits of display for added accuracy in measuring these low frequencies. The result is a resolution of .01 Hz through 500 Hz, and .1 Hz from 500—20 KHz. The decimal place is automatically placed when the resolution multiplier circuits are activated.

The resolution multiplier provides additional filtering of low frequency signals to prevent interference from noise information. This filtering action, combined

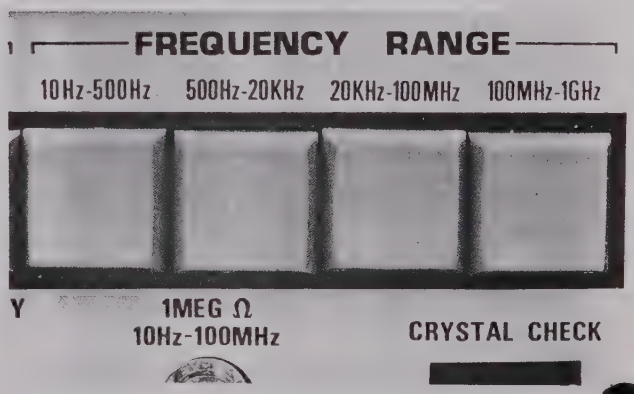


Fig. 13—The four frequency range buttons automatically position the decimal for direct readouts. Notice the ranges are listed above each button.

ith the adjustable sensitivity control associated with ıe 1 Megohm input, allows the measurement of audio gnals that are generally not possible to measure with ther high-sensitivity counters. See the "Applications" ction of this manual for details about the common ıu[illegible]f noisy signals. The 1 Megohm input should e u[illegible] for all audio measurements.

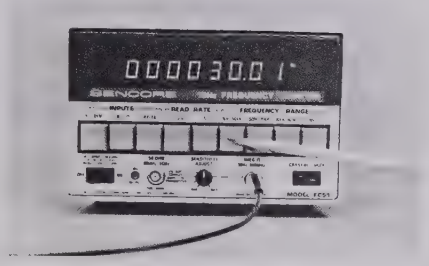
equencies between 20 KHz and 100 MHz are fed rectly into the counting section of the FC51 through special pre-amplifier. This allows measurements with solution down to 1 Hz for this frequency range. ıe 20 KHz—100 MHz FREQUENCY RANGE button can be used with either the 50 Ohm or the 1 Megım input. This frequency range button is also used th the CRYSTAL CHECK function.

ıe final button routes the signal through an internal :1 prescaler for measuring frequencies between 0 MHz and 1 GHz. This range button is only used th the 50 Ohm input since the capacitive loading of e 1 Megohm input would make it less useful above 0 MHz. Signals applied to the 1 Megohm input jack ll not measure if the 100 MHz—1 GHz range button selected. The decimal place in the digital readout automatically positioned when the internal prescaler switched in, which eliminates the need to mentally move decimal places for any of the frequency ranges covered by the FC51.

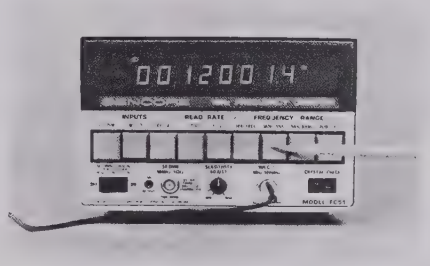
It should be noted that there is some overlap between the frequency ranges that is not noted on the front panel. For example, the 20 KHz—100 MHz range is generally usable as low as 1 KHz, and as high as 110 MHz. The 1 KHz—20 KHz portion of this range will usually not be used, however, because the next lower range (500 Hz—20 KHz) offers one more digit of resolution, which provides more accurate low-frequency measurements. The following table lists typical overlaps so that you know the approximate counting range of each FREQUENCY RANGE button.

TABLE III – TYPICAL FREQUENCY RANGES

RANGE SELECTED	USABLE RANGE	INPUT USED
10 Hz - 500 Hz	8.5 Hz - 550 Hz	1 Megohm
500 Hz - 20 KHz	450 Hz - 21 KHz	1 Megohm
20 KHz - 100 MHz	1 KHz - 110 MHz	Either
100 MHz - 1 GHz	50 MHz - 1.1 GHz	50 Ohm



Frequencies between 10 Hz and 500 Hz are multiplied by 100.



Frequencies between 500 Hz and 20 KHz are multiplied by 10.

Frequencies between 20 KHz and 100 MHz are read direct.

Frequencies between 100 MHz and 1 GHz are divided (prescaled) by 10.

Fig. 14—All frequencies are read direct with maximum resolution when the proper range button is pressed.

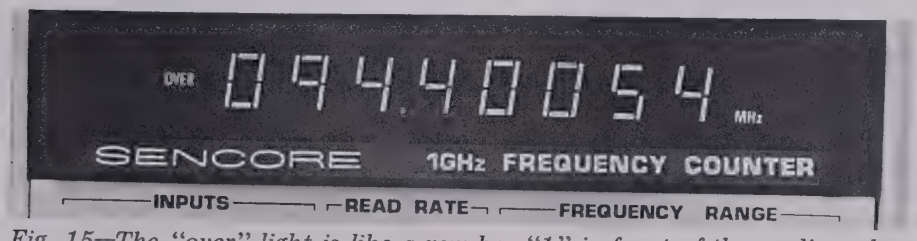


Fig. 15—The "over" light is like a number "1" in front of the reading when frequencies over 1 GHz are read. Here we see a frequency of 1094 MHz or 1.094 GHz.

SELECTING READ RATE

The FC51 allows the choice of two different read rates.

In general, the .1 second READ RATE button is used when a fast update time is desired. The use of the .1 second READ RATE, however, results in one less digit of resolution for each frequency range compared to the 1 second READ RATE. The .1 second read rate will also show a more rapid change in the reading if the tested signal is changing in frequency. An example of such a changing frequency is one provided by an LC tank (non-crystal) oscillator circuit.

The 1 second READ RATE offers an extra digit of resolution. Since the input frequency is counted for a longer period of time, frequency changes (such as in the LC tank mentioned above) will be averaged which often provides a more stable count. This frequency averaging often makes the 1 second READ RATE easier to use.

The FC51 offers 8 different options of resolution, depending on which FREQUENCY RANGE and which READ RATE options are used. Table IV lists the different resolution options that are available.

TABLE IV– FC51 RESOLUTION OPTIONS

FREQUENCY RANGE	READ RATE	
	1 Sec	.1 Sec
10 Hz - 500 Hz	.01 Hz	.1 Hz
500 Hz - 20 KHz	.1 Hz	1 Hz
20 KHz - 100 MHz	1 Hz	10 Hz
100 MHz - 1 GHz	10 Hz	100 Hz

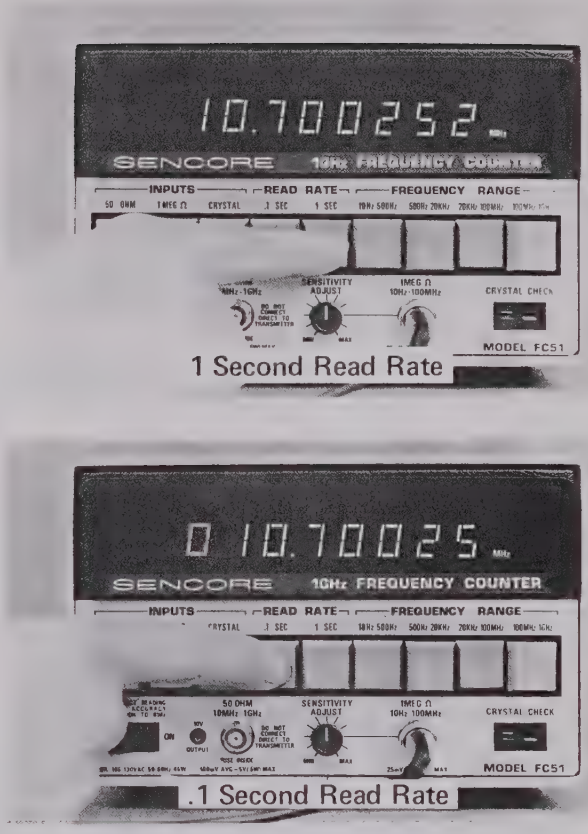


Fig. 16—The 1 Second Read Rate provides one extra digit of readout and the .1 Second Read Rate provides faster updates.

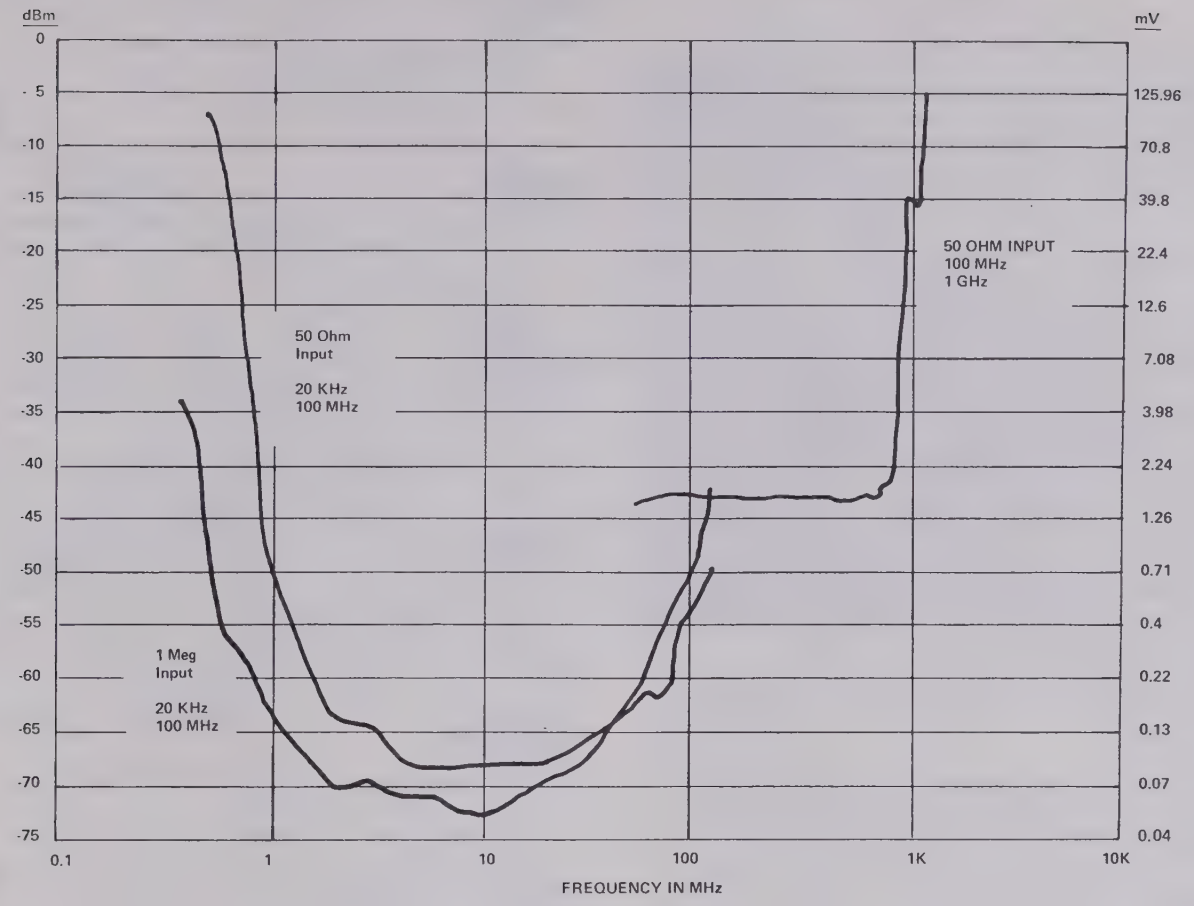
INCREASING INPUT SENSITIVITY WITH (OPTIONAL) WBA52

The input sensitivity of the FC51 has been designed to provide complete troubleshooting capabilities in almost all applications requiring a frequency counter. The 50 Ohm input, for example, has sufficient sensitivity to allow the use of the supplied 39G138 pickup loop to trace signals from oscillators, frequency multiplier stages, and output stages of a transmitter. Added sensitivity can actually be a detriment in some of these applications, as additional sensitivity also increases the chances of picking up noise signals which can lead to erratic counting.

There are, however, a few applications that require additional sensitivity. Examples would include measuring the output of a signal generator that has limited output, using the AN210 Antenna for picking up signals at greater distances, or using the 39G138 Pickup Loop for tracing signals that are extremely low in amplitude. The optional WBA52 provides approximately 30 dB (see Graph III for typical gain) of gain from 1 MHz through 1 GHz for these special applications. The WBA52 simply connects to either of the FC51 input jacks and receives power from the 10V DC Accessory Output Jack on the FC51 front panel. The WBA52 can be used when the FC51 is powered from either the AC line or from 12 VDC.

Fig. 17—The WBA provides extra sensitivity for special low-level signal tracing applications. The WBA52 is powered by the FC51 DC output jack.

GRAPH 3 – 50 Ohm and 1 Megohm typical input sensitivity with WBA52 Amplifier.



Additional applications of the WBA52 include boosting signal levels from the output of an RF generator or uses other than counting with the FC51. These applications are covered in the WBA52 instruction manual.

The input of the WBA52 is terminated in a well-matched 50 Ohm load so it will operate properly throughout its entire frequency range. Several signal input options are available, including:

1. The AN210 Antenna may be connected directly to the WBA52 input for off-the-air monitoring with high sensitivity.

2. The AN210 Antenna may be connected through the extension cable supplied with the 39G138 pickup loop for similar measurements, but with the antenna separate from the amplifier. This is especially handy when using the WBA52 and FC51 in portable applications.

3. A receiver antenna may be mounted on a car or truck and connected to the WBA52 (through appropriate adapters) to allow you to drive up near to a transmitter and measure its output.

4. The short 39G138 Pickup Loop may be connected directly to the WBA52 for signal tracing. The short loop offers the advantage of having a minimum amount of cable to keep noise pickup to a minimum.

5. The 39G138 Pickup Loop may be used with the extension cable supplied with the FC51 for getting the loop into more difficult to reach locations.

6. The output of a generator may be measured with a direct connection from the generator output to the WBA52 input. The BNC/BNC extension cable supplied with the FC51 is used with generators with a BNC output jack, or use appropriate adapter cables for generators with other output connectors.

You may find that some measurements using the pickup loop result in noise pickup because of the extremely high sensitivity provided by the WBA52. This can usually be corrected by moving the pickup loop slightly to provide a greater amount of signal and less noise. Signals below 100 MHz may be measured with the WBA52 connected to the 1 Megohm input. This allows the sensitivity control to be used to adjust for optimum sensitivity in noisy signal conditions.

WARNING

Do not exceed the input limits of the WBA52 50 Ohm load. Do not exceed 3.5 Volts (RMS) AC or 100 Volts DC. The use of the supplied pickup loop or AN210 Antenna will prevent the possibility of damaging the input circuits.

To use the WBA52 with the FC51:

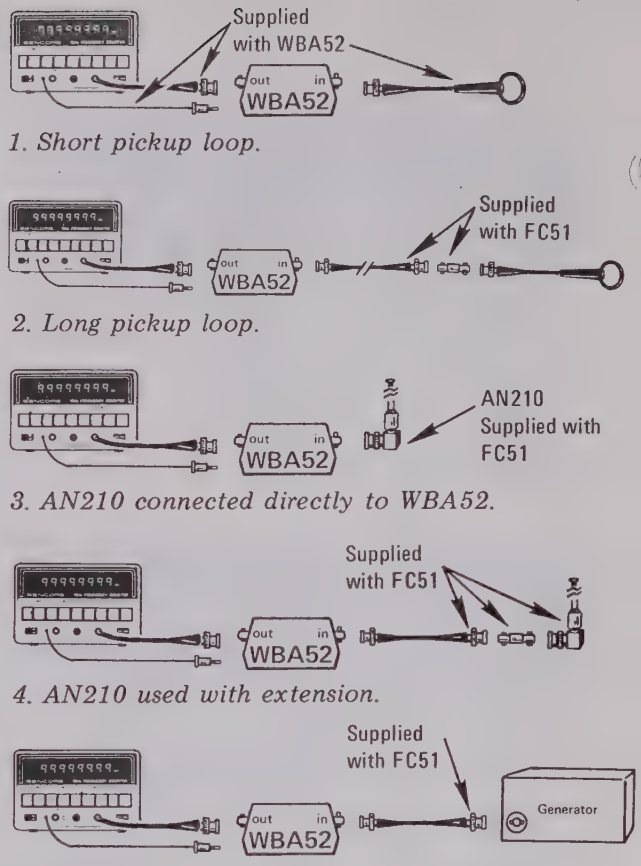
1. Connect the supplied DC power lead to the standard power adapter connector on the "output" end of the WBA52. Connect the pin plug on the other end of the power lead to the ACCESSORY OUTPUT jack on the front of the FC51. Note: The common power supply connection is automatically made through the shield wire of the WBA52 output cable.

2. Connect the output jack of the WBA52 to either FC51 input jack using the guidelines outlined above. A BNC/BNC adapter cable is supplied with the WBA52 for this connection.

3. Connect your input signal using the guidelines outlined above.

4. Select the INPUT, READ RATE, and FREQUENCY RANGE buttons on the FC51 as would normally be done without the WBA52 in circuit.

5. Read the resulting frequency on the digital readout.



1. Short pickup loop.

2. Long pickup loop.

3. AN210 connected directly to WBA52.

4. AN210 used with extension.

5. Connection to generator.

Fig. 18—These are five typical options of supplying signals to the WBA52.

10 MHz REFERENCE OUTPUT

The FC51 provides a buffered output jack which is connected to the internal high accuracy timebase oscillator. This output jack provides a 10 MHz signal that may be used as a reference source for calibrating less accurate counters or scopes. This same output jack may be used for testing the accuracy of the FC51 frequency calibration by comparing it with an external 10 MHz frequency standard such as that available from some communications monitors or receivers capable of receiving the National Bureau of Standards WWV signals. See the "Maintenance" section of this manual for details.

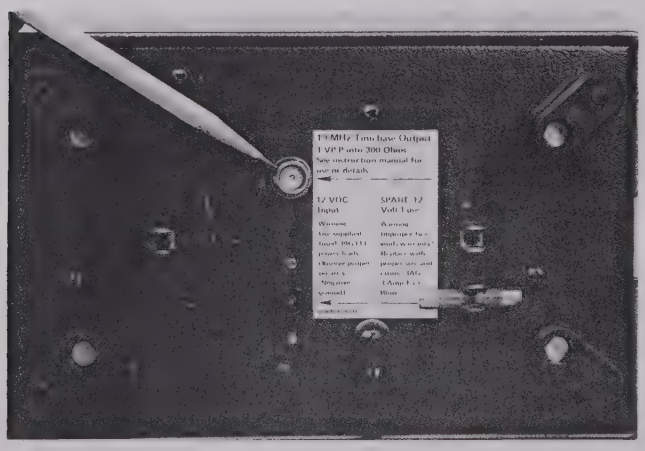


Fig. 19—The high accuracy 10 MHz timebase signal is available through the buffered output jack on the rear of the unit.

The output signal level is 1 V P-P (into 300 Ohms). This signal may be used as a reference for driving other frequency counters that are equipped with an external clock input jack, as long as the output signal is properly buffered to drive the input of the other counter. Most counters require a TTL compatible signal, but be sure to refer to the instructions for the specific counter being used for details. The buffer circuit should be added to the second counter for best operation. A Schmitt trigger IC is the best type of buffering since any noise or ringing that is picked up in the inter-connecting cable will be eliminated.

A final application of the 10 MHz output signal is to verify that the RF protection fuse in the 50 Ohm input of the FC51 is good. Details on this use of the 10 MHz output are located in the "Replacement of the 50 Ohm Input Fuse" section of this manual.

TIME BASE MODULE

The accuracy of the FC51 is determined by the output frequency of the timebase module. This module contains the high accuracy crystal oscillator, the control circuits for the proportionally-controlled oven, and the oven heating circuits. The entire timebase is designed as a replaceable module which is removed with two mounting screws and two cable connections. This feature allows the FC51 to be recalibrated without the need of returning the entire counter to the Sencore Service Department. Replacement modules are available from the Sencore Service Department for a nominal calibration charge. The freshly calibrated module is installed into the FC51 at regular intervals to maintain the accuracy of the FC51 to its published specification. The module that has been removed from the counter is then returned for credit, or if desired, a spare module may be purchased so you have a backup module available anytime you suspect the accuracy of the FC51 is outside the rated specifications.

Details on testing the FC51 accuracy, replacing the calibrated timebase module, or recalibration in the field are included in the "Maintenance" section of this manual.

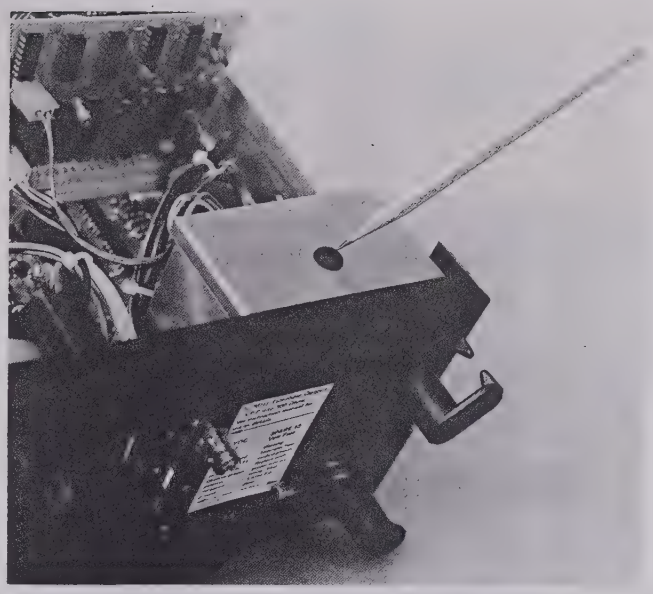


Fig. 20—The replaceable timebase module eliminates the need of sending the entire frequency counter in for calibration.

APPLICATIONS

For most applications, the technician merely connects the test leads to the frequency source, selects the proper INPUT, FREQUENCY RANGE and READ RATE buttons, and reads the frequency on the digital readout. Certain types of signals are a little more difficult to measure because of low amplitudes or interfering signals. This section will explain why the FC51 may give erratic readings on some signals, and what the technician should do to produce a stable reading.

Erratic readings generally come from two types of signals. The first is an AM or FM modulated signal. A modulated signal can often be counted without any special procedures but if the modulation level is too high erratic counting may result. The second cause of erratic counting is due to extraneous signals riding on the desired signal. This condition is most prevalent in lower frequency signals, audio through a few Mega-Hertz. The FC51 provides built-in features that allow most of these signals to be counted. We will discuss the causes of the erratic counting and the proper methods of stabilizing the reading in this section of the manual.

AM MODULATED SIGNALS

In many cases, the FC51 will properly count the carrier of an AM-modulated signal. The exception is when the modulation level is very high. High level AM modulation may result in an erratic count or a frequency reading that is lower than expected. The reason is that the signal level of an AM signal is constantly varying. During periods of high modulation, a portion of the signal falls close to zero. The FC51 will then count only that portion of the signal that is larger than the sensitivity rating of the input circuits but will fail to count those other portions of the signal that are low-amplitude.

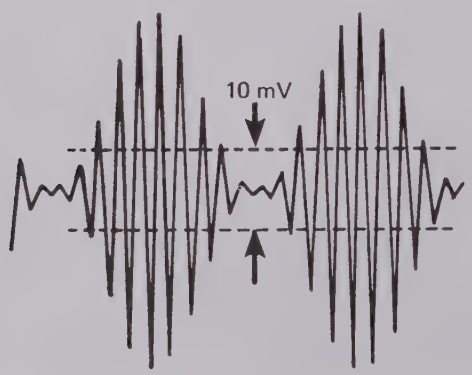


Fig. 21—The amplitude of an AM modulated signal may drop below the sensitivity point of the FC51, causing part of the signal to be missing by the counting stages.

The easiest way to prevent counting errors when measuring the carrier frequency of an AM transmitter is to "dead-key" the transmitter or transmit without modulation. This can generally be done without seriously affecting the transmitted signal as the entire count can be made in two seconds or less. If it is not practical to remove the modulation for this amount of time (as in the case of a commercial AM broadcast station) the counting error can be minimized by increasing the amount of signal that is fed to the counter. You must keep the protection limits of the counter in mind, of course, when increasing the input signal. Increasing the input signal will increase the amount of signal that is present during modulation peaks which will keep the counting error to a minimum. It will also help to use the 1 second read rate instead of the .1 second read rate, because the 1 second mode will average the number of missed counts over a much longer period of time to keep a more stable reading on the digital display.

FM MODULATED SIGNALS

An FM signal may cause erratic counting because the frequency of the signal is constantly changing. As with AM signals, the best way to insure a stable co is to remove the modulation during the period of t that the count is taken. If this is not practical, be sure to use the 1 second read rate. This will average the amount of time that the frequency is higher than the carrier with the time that the frequency is lower than the carrier and provides a frequency reading that is very close to the actual carrier frequency.

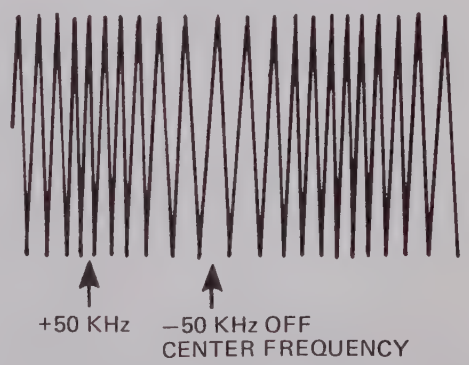


Fig. 22—The frequency of an FM modulated signal i constantly changing, causing erratic counting due t the averaging of different frequencies.

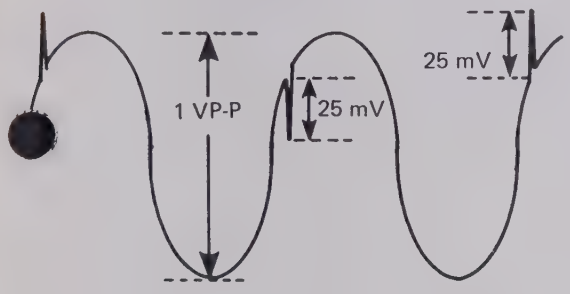
NOISY SIGNALS

Erratic counting of low frequency signals fall into fo general categories: 1.) An audio signal with cross-ov or harmonic distortion, 2.) A signal with an unwante

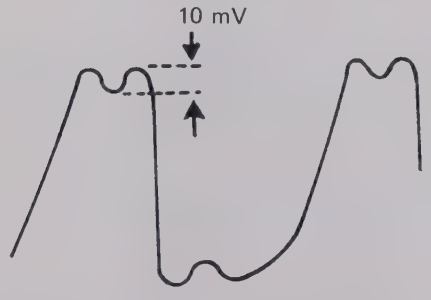
:econd frequency (like ripple) super-imposed on the lesired frequency, 3.) A digital signal that has some of he mixing or input products mixed with the larger-mplitude output signal, and 4.) A fast risetime pulse vhich produces ringing on the frequency counter cable. Th[illegible]are times when you cannot determine the exact :aus[illegible] of an erratic reading because the interfering sig-ıal may have too high a frequency, or too fast a rise-ime to observe on a standard oscilloscope. The symp-om of erratic counting, however, almost always points o one of these four conditions. Let's see how each f these signal conditions cause erratic counting and vhat we can do to prevent errors in our frequency eadings.

DISTORTED SIGNALS

Two types of distortion that can cause erratic readings re cross-over distortion and harmonic distortion. In ither case, the chance of miscounting depends on the mount of distortion. The sensitivity of the FC51 at udio frequencies is generally better than 10 mV. Any listortion that is greater than 10 mV will be counted long with the fundamental frequency. Figures 23 nd 24 show examples of distorted signals. Notice hat the amount of distortion is large enough to trigger he counting circuits.



ig. 23—A sinusoidal waveform with two types of rossover distortion which may cause false counting.



ig. 24—Harmonic distortion may cause the reading to e two or three times that of the fundamental freuency.

Two features of the FC51 allow signals of this type o [illegible] measured. The first is the Sensitivity Control hat is used with the 1 Megohm input circuits, and the econd is the resolution multiplier that is automatical-y switched into circuit whenever a Frequency Range utton below 20 KHz is used.

The sensitivity control is simply adjusted until the FC51 produces a stable count. The reason that this adjustment creates a stable count is that the sensitivity adjustment reduces the amplitude of both the signal and the distortion. When the control is set properly, the distortion component will be smaller than the input sensitivity, but the fundamental frequency will be large enough to trigger the counter.

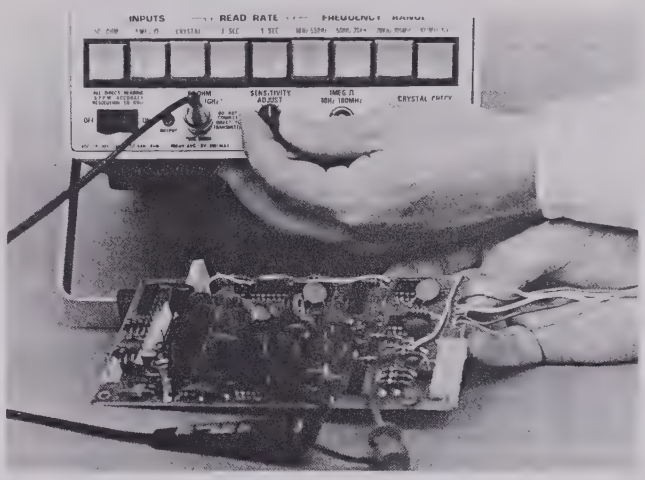


Fig. 25—The sensitivity control of the FC51 allows stable counting of distorted or noisy signals.

The resolution multiplier provides even greater stability because it uses a Phase Locked Loop (PLL) circuit to multiply the incoming frequency by either 10 or 100 times, depending on which Frequency Range button is used. The PLL can only lock to one frequency at a time, and the distortion product is often times outside the lock-in range of the PLL circuits. A frequency of 400 Hz, for example, will have a second harmonic of 800 Hz, and a third harmonic of 1200 Hz. Both of these frequencies are above the lock-in range of the 10—500 Hz range.

EXTRA SIGNALS

Erratic counting is often caused by the circuit under test either generating or picking up unexpected signals. A stereo FM receiver, for example, may have a small amount of 19 KHz or 38 KHz signal present along with the audio output signal. Other circuits may act as radio receivers and pick up high-powered commercial AM, FM, or TV stations and mix these RF signals with the audio output signal. Other causes of interference include hospitals with diathermy machines, brush-type motors, or switching power supplies. In each of these cases, you may not be able to see the interfering signal with an oscilloscope, but the extremely wide bandwidth (1 KHz—100 MHz) and high sensitivity of the input circuits of the FC51 may lock onto the interfering signal and cause an extremely high reading (such as 80 MHz) or an erratic count.

The solution for this type of interference is the same as with audio distortion. The sensitivity control will allow you to reduce the sensitivity sufficiently to allow the desired signal to be counted without the inter-

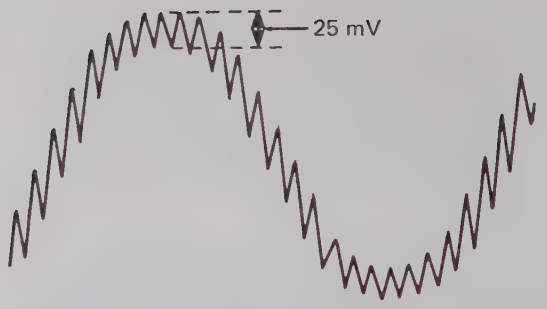


Fig. 26—An audio signal with a super-audible signal from the FM multiplexing superimposed.

ference. The PLL of the resolution multiplier will usually be most effective (for those frequencies below 20 KHz) because the interfering signal is usually in the RF frequency range.

DIGITAL NOISE

Digital signals are subject to noise which is caused by a small amount of input signal feeding through to the output or signals from one stage feeding to another through the power supply lines. Fig. 27 shows a typical TTL signal at the output of a "divide by ten" stage. The small amount of noise riding on the 4 Volt signal is a portion of the input signal feeding through the stage. This is not enough signal to cause improper operation of the next stage, but is enough to cause the frequency counter to read the higher (input) frequency. The sensitivity control allows the signal level applied to the counter input to be reduced enough to eliminate the higher frequency noise from affecting the reading.

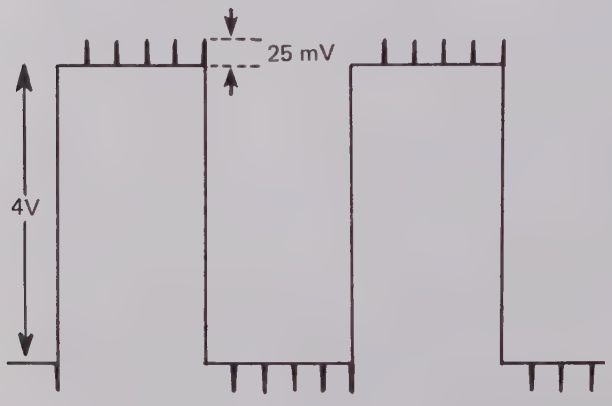


Fig. 27—The output of a digital divide-by-ten stage with a small amount of input signal superimposed.

PULSE RINGING

Fast rise-time pulses may cause erratic readings due to ringing in the coaxial cable connected to the 1 Megohm input. The ringing is a result of the impedance mismatch between the counter input cable and the 1 Megohm input. The resulting reflected signal passes down the cable towards the signal source where it is again reflected towards the counter. These reflections continue until the resistance of the cable damps the ringing signal.

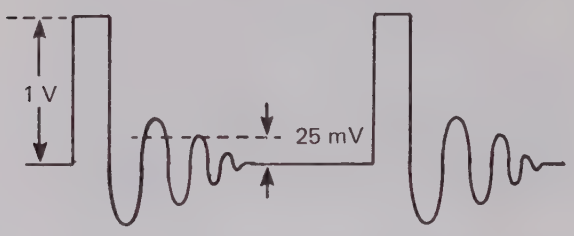


Fig. 28—Pulse waveform causing ringing on cable due to impedance mismatch.

The sensitivity control of the FC51 allows the ringing signals to be reduced to prevent false counts. The noise reduction is further aided with the isolation capacitor that is included in the FC51 Frequency Counter Probe. This capacitor forms an integrating filter which reduces the rise-time of the signal passing to the counter and prevents the ringing from starting in the first place. Elimination of these ringing pulses are important in some circuits since the ringing signal coming back down the cable from the counter may cause the circuits following the test point to act improperly.

MAINTENANCE

WARNING

These servicing instructions are for use by qualified personnel only. To avoid electric shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

INTRODUCTION

This Maintenance and Service Section will help you maintain your FC51 within the published specifications and assure years of useful application.

VERIFYING COUNTER ACCURACY

The accuracy of the FC51 may be verified at any time by injecting a signal of known frequency with at least a .05 ppm (.000005%) accuracy. To obtain a full accuracy check, the frequency must be at least 10 MHz.

If such a signal is not available, the color subcarrier of a television station will allow a check to within .28 ppm (.000028%) providing the local television station's signal is locked (GEN-LOCKED) to an incoming network signal. A phone call to the local station will determine if the broadcast signal is locked to network sync.

To verify the FC51 accuracy:

1. Remove the cabinet of a color TV receiver.

WARNING

TV receivers contain possible lethal voltages at certain areas — especially around the high voltage section, boost and focus voltage sections, and horizontal output stages. Use extreme caution in making connections to avoid dangerous shocks to yourself or damage to the FC51.

2. Locate the output of the receiver's burst oscillator. Make sure this test point is isolated by at least one amplifier stage from the 3.58 MHz oscillator to prevent the FC51 test leads from pulling the oscillator off frequency. The 39G138 Pickup Loop may be used to prevent circuit loading.

3. Tune in a local station whose signal is locked to a network color program.

4. Fine-tune the receiver for a proper color display on the TV picture tube.

5. Connect the 1 Meg input of the FC51 to the 3.58 test point.

6. Verify the receiver is still properly color-locked after the connection is made.

7. Select the 1 Hz Read Rate, and the 20 KHz - 100 MHz Frequency Range.

8. Read the burst oscillator's frequency.

The proper frequency of the burst oscillator is 3.579545 MHz. A .5 ppm tolerance (.000005%) allows ± 3 counts from this frequency. If the reading is outside this range (3.579542-3.579548) the timebase of the FC51 should be recalibrated.

ACCESS / DISASSEMBLY

WARNING

Always disconnect the FC51 from the AC line before removing any covers!

Access to the interior of the FC51 for recalibration or service may be obtained using the following procedures.

1. Remove the four screws (two on each side) holding the top cover in place.

2. Lift the top cover free from the remainder of the unit

3. Remove the four screws (two on each side) that hold the bottom cover in place.

4. Lift the bottom cover free from the remainder of the unit.

NOTE: Access is now available to all recalibration controls and to the 50 Ohm input fuse.

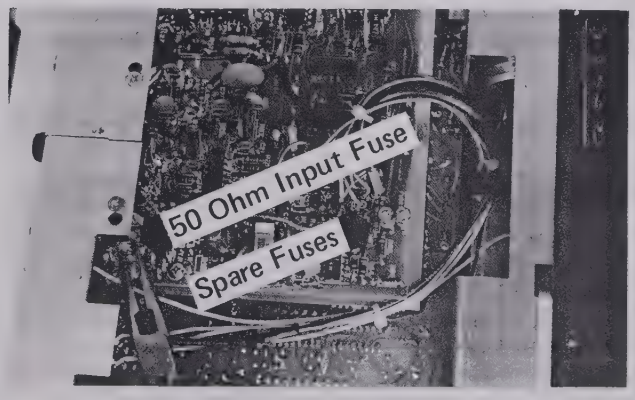


Fig. 29—The special 50 Ohm load RF fuse is removed by carefully pulling it out of the special socket. Notice the two spare fuses that are included.

For re-assembly, simply reverse the above procedure.

To replace the 50 Ohm input fuse:

1. Remove the bottom cover of the FC51 as explained in Access/Disassembly.

2. Locate the 50 Ohm input fuse at the front of the input PC board.

3. Grasp the fuse firmly and remove vertically taking care not to twist it.

4. Replace the fuse with one of the spares (two) located at the rear of the input PC board.

WARNING

Always replace the 50 Ohm input fuse with the type and value specified. Larger fuses may cause internal damage to the FC51 and you will void all warranties. Additional spares (Part No. 44G21) may be obtained through the Sencore Parts Dept., 3200 Sencore Drive, Sioux Falls, SD 57107, for $1.25.

10 MHz CLOCK & OVEN MODULE REPLACEMENT

The accuracy of the FC51 is determined by the frequency of the 10 MHz timebase oscillator. This oscillator is located in a module that contains the crystal, oscillator, and the control circuits for the proportionly controlled oven which maintains a constant temperature for the entire module to prevent accuracy drift as the ambient temperature changes.

You should also realize that the accuracy of any frequency counter is dependant on long-term drift of the reference crystal's resonant frequency. The drift is kept to a minimum inside the FC51 by the fact that the crystal is always operated at the same temperature. Additional precautions are taken during manufacturing and factory re-calibration to make sure that the amount of drift is kept to a minimum. This drift factor determines how often the FC51 should be re-calibrated. In communications work, the FC51 will maintain its accuracy to better than FCC specifications for one full year if the frequency band you are servicing falls below 800 MHz, and for 6 months for frequencies between 800 MHz and 1 GHz. You should check the accuracy at these intervals to keep the stability of the FC51 within FCC specifications.

One feature of the FC51 that allows the easist method of maintaining this accuracy is the replacable module. This module is designed to be removed from the FC51 by simply disconnecting two cable connections and removing two mounting screws. Replacement modules, which have been freshly calibrated, are available from the factory Service Department. You simply order a new module from the factory any time that you feel your FC51 should be recalibrated. You will be billed for the price of the replacement module and for the price of re-calibration. You then exchange modules in your FC51 and then have the option of returning the old module for credit (you will still be billed the re-calibration charge) or keeping the module as a spare and paying for the module and calibration. Most technicians prefer the first option which reduces the cost of maintaining the FC51 accuracy.

To replace the timebase module:

1. Remove the top cover of the FC51 following the procedures listed in the "Access and Disassembly" section.

2. Disconnect the two connectors that are used to connect the module to the other circuits in the FC51. Notice that the connectors are different sizes to prevent the possibility of exchanging them during installation. The larger connector plugs into the main P.C. board, and the smaller (2-conductor) connects to the timebase P.C. board.

3. Remove the two screws (located in the rear panel of the FC51) that hold the module in place.

4. Remove the module from the FC51.

5. Replace the module with the second calibrated module by following the prodedures outlined above in the reverse order.

RECALIBRATION PROCEDURES

The FC51 should be checked at regular intervals (see the "10 MHz Clock and Oven Module Replacement" section for details) to verify performance within published specifications. If the FC51 is found to be outside of specifications, the Sencore Service Department (address inside back cover of this manual) provides complete recalibration facilities, using standards that are traceable directly to the National Bureau of Standards, for a nominal recalibration charge. If the only calibration that is required is the timebase module, a replacement module may be ordered from the Service Department for direct replacement in the field.

If the proper standards are available for recalibration, the following procedure may be used to restore the FC51 to its rated accuracy.

WARNING

Do not attempt to recalibrate your FC51 unless the proper equipment and signal sources are available. The high accuracy of this unit can only be assured if these conditions are met.

The following are the minimum recommended specfications for the equipment required to recalibrate the FC51:

Equipment	Minimum Specification
Frequency Standard	PREFERRED: 10 MHz, .05 ppm accuracy. ALTERNATE: 10-100 MHz, .05 ppm accuracy.
Adjustable Signal Source(s)	8.5 Hz-1 GHz, adjustable output from 10 mV (-27 dBm) through 700 mV (+10 dBm).
3½ Digit Meter	.1% DC volts accuracy, capable of measuring DC current to 1 uA resolution.

TIMEBASE MODULE

TEMPERATURE CONTROL
(COARSE ADJUSTMENT)

The following procedure is necessary if the module has been opened for service. It sets the temperature sensing circuits to be close to the proper point. The coarse adjustment should always be followed by the fine adjustment listed below. The coarse adjustment should be made with the oven compartment open.

To set the oven temperature adjustment to its coarse setting:

1. Connect a voltmeter to pin 3 of IC1 located on the oscillator printed circuit board. Connect the common meter lead to ground.

2. Turn on the FC51 and adjust the temperature adjustment control *(R-503)* until the voltage read is 3.26 Volts. Notice that this control is a multi-turn adjustment.

TEMPERATURE CONTROL
(FINE ADJUSTMENT)

This adjustment should be made every time the timebase module is recalibrated. If the module has been repaired, the coarse adjustment listed above should be used before this procedure so that the adjustment is set close to the final calibration point.

To set the oven temperature adjustment to its fine setting:

1. Remove the jumper wire on the main P.C. board (J1). Notice that this jumper is in special sockets and is not soldered in place.

2. Connect a current meter capable of reading 1000 uA full-scale between the two jumper connections.

3. Connect the oscillator module to the FC51 and allow the unit to operate for a minimum of 30 minutes to make sure that the oven control circuits have completely stabilized.

4. The meter should read 330 uA. If it does not, adjust the oven temperature control *(R-503)* for the proper reading. This control is accessible through the calibration access hole in the bottom of the oscillator module.

   a. If the current reading is *hi*, turn the adjustment *clockwise* about ¼ turn.

   b. If the current reading is *low*, turn the adjustment *counter-clockwise* about ¼ turn.

5. Allow the FC51 to sit for a minimum of 10 minutes before making any additional adjustments to allow the oven control circuits to totally stabilize.

6. Repeat steps 4 and 5 as often as necessary to obtain the proper oven control current. As the reading gets closer to the proper current, reduce the amount of the adjustment from 1/4 to 1/8 turn as indicated by how close you were in your last reading.

7. Disconnect the current meter and replace jumper J1.

OSCILLATOR FREQUENCY ADJUSTMENT

NOTE: Do not attempt to make this adjustment until the oven regulator circuits have been properly adjusted.

This adjustment sets the frequency of the timebase oscillator to be within .1 ppm. Two procedures are listed. The first uses the readout of the FC51 as an indicator, and the second beats the 10 MHz clock with a 10 MHz signal of known accuracy. The second method is preferred because it results in a setability much closer to the correct frequency. You must use a frequency standard that is accurate to at least .05 ppm, and .01 ppm is preferred. This frequency source should have a frequency of at least 10 MHz. If the frequency is exactly 10 MHz or an even multiple (such as 20 MHz), it is possible to set the adjustment more accurately than with another frequency. The reference source must be traceable to the National Bureau of Standards in order to be reliable.

The following procedure should be used if the reference frequency is not 10 MHz:

1. Supply the signal to the appropriate input. Select the 1 Second Read Rate button and the frequency

range button that gives the best resolution (most digits of readout).

2. Adjust the frequency adjustment capacitor *(C509)* until the reading of the FC51 agrees with that of the frequency standard.

PREFERRED METHOD

The following procedure is the preferred method of calibration. This procedure requires a reference frequency of 10 MHz and an oscilloscope with both vertical and horizontal inputs that will operate at 10 MHz. The Sencore PS163 or PS29 scopes will both operate satisfactorily for this procedure.

1. Connect the 10 MHz output jack on the back of the FC51 to the vertical input of the scope.

2. Connect the 10 MHz reference signal to the horizontal input of the scope.

3. Adjust the frequency adjustment capacitor *(C509)* until the pattern on the scope is moving the least amount possible. The actual ppm error of the timebase oscillator compared to the reference frequency can then be calculated using the following procedure:

a. If the lissajous pattern is "turning" very slowly, measure the amount of time for the signal to go through 360° phase shift. This is easiest to do by measuring the time when the signal passes through the 0° point twice as illustrated in Fig. 30.

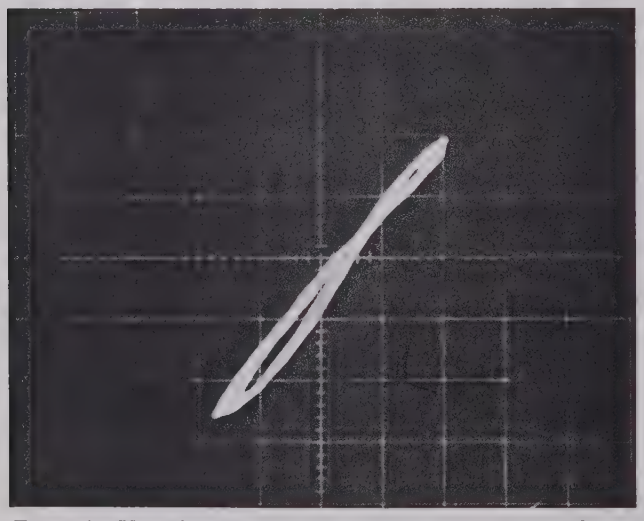


Fig. 30—Use the 0° phase point as a reference when a scope is used to measure the accuracy of the FC51.

b. If the lissajous pattern is "turning" very quickly, measure the amount of time for the pattern to pass through the 0° phase point 11 times.

c. Refer to the table to determine the ppm accuracy or calculate the accuracy as follows:

1. If procedure 3a was used, the ppm accuracy is determined with the formula: ppm=1/(10t).

2. If procedure 3b was used, the ppm accuracy is determined with the formula: ppm=1/t.

Time (Seconds)	PPM ACCURACY* 1 Cycle (Slow Change)	10 Cycles (Fast Change)
1	.1	1
2	.05	.5
3	.033	.33
4	.025	.25
5	.02	.20
6	.017	.17
7	.014	.14
8	.012	.12
9	.011	.11
10	.01	.1
20	.005	.05
30	.0033	.033
40	.0025	.025
50	.002	.02
60	.0017	.017

**NOTE: These accuracies are only correct if the reference frequency is more accurate than the calculation point. For example, a .0017 ppm is only accurate if the reference oscillator is accurate to $1x10^{-10}$ or better.*

SENSITIVITY ADJUSTMENTS AND TESTING

The following procedures list both the recalibration procedures for adjusting the internal sensitivity adjustments and the signal levels to use to verify proper operation at the extreme ends of each input range. The tests are also shown in tabular form at the end of the section.

FREQUENCY MULTIPLIER PLL

This adjustment sets the lock-in range of the phase locked loop used for the 10 Hz-20 KHz ranges. When this adjustment is properly set, the PLL will lock over the entire frequency range.

To set the PLL circuit:

1. Set the front panel sensitivity control fully clockwise.

2. Set R272 on the input board fully clockwise as viewed from the front of the unit.

3. Feed 8.5 Hz at 50 mV (-13 dBm) into the 1 Megohm input jack and select the "1 Meg" Input, ".1 Sec" Read Rate, and "10 Hz-500 Hz" Frequency Range buttons.

4. Slowly turn the PLL lock control *(R272)* counterclockwise until the display just stabilizes.

. Change the input frequency to 500 Hz, and select he "500 Hz-20 KHz" Frequency Range button. The isplay should still show a stable reading. If it does ot, increase the setting of the PLL lock control *R272)* slightly until the frequency locks.

. Check the upper lock-in range by increasing the requency of the input signal to 20 KHz. You may eed to increase the generator output slightly. The ignal should be properly locked. If the signal goes ut of lock, the input circuits or PLL circuit should e checked for proper operation.

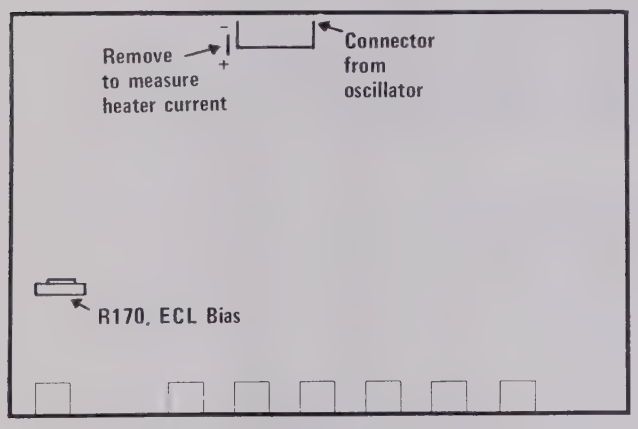


Fig. 31—Calibration location diagram, input P.C. board.

H[illegible] FREQUENCY SENSITIVITY

The adjustment of these controls provides optimum sensitivity at high frequencies. These procedures require the use of a generator that will put out 100 MHz with adjustable output levels.

To set for best sensitivity:

1. Begin by setting the ECL Bias control (R170 on the main P.C. board) fully clockwise as viewed from the front of the unit.

2. Inject 100 MHz at 0 dBm (224 mV) into the 1 Megohm input. Select the "1 Meg" Input, ".1 Sec" Read Rate, and "20 KHz-100 MHz" Frequency Range buttons.

3. Slowly turn the ECL Bias control *(R170)* until the counter just begins to read.

4. Remove the input signal. The readout should go to all zeros. If not, turn R170 slightly clockwise until the reading goes to zeros.

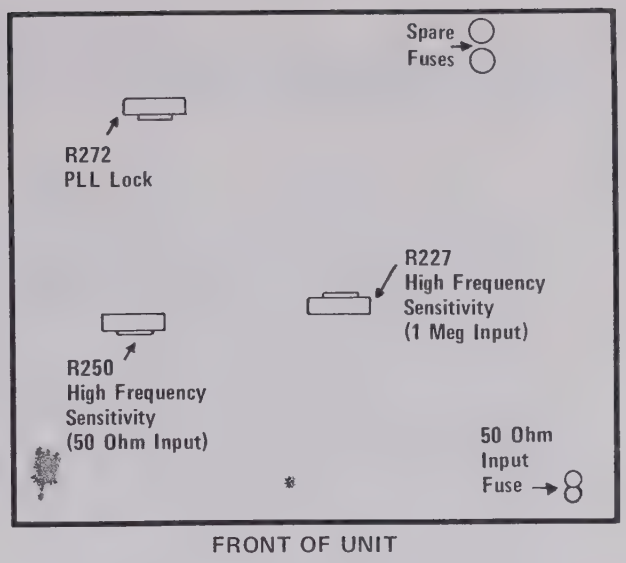

Spare Fuses
R272 PLL Lock
R227 High Frequency Sensitivity (1 Meg Input)
R250 High Frequency Sensitivity (50 Ohm Input)
50 Ohm Input Fuse
FRONT OF UNIT

Fig. 32—Calibration location diagram, main P.C. board.

5. Repeat steps 3 and 4 until proper dropout operation is obtained.

6. Re-apply the 100 MHz signal. Reduce the generator output until the reading goes to zeros.

7. Adjust the High Frequency Sensitivity control *(R227)* on the input P.C. board until you get a locked-in reading.

8. Repeat steps 6 and 7 until no further improvements in input sensitivity is possible.

9. Move the signal to the 50 Ohm input.

10. Adjust the generator for -8 dBm (90 mV).

11. Select the "50 Ohm" Input, ".1 Sec" Read Rate, and "100 MHz-1 GHz" Frequency Range buttons.

12. Adjust the Input Detection control *(R250)* until the counter reads the input signal.

13. Reduce the generator output to -9 dBm (80 mV). The reading should go to all zeros. If not, readjust the control slightly and repeat steps 10 through 12 to confirm proper operation.

14. Test the operation of all range limits using the following chart as a guide of the minimum acceptable specifications at each frequency. If the results vary greatly from those shown in the chart, you should troubleshoot the associated input circuits.

RANGE LIMIT VERIFICATION

INPUT	FREQUENCY	CORRECT READOUT FOR INPUT AMPLITUDE				ADJUSTMENT
1 MEG	10 Hz – 500 Hz	LOW:	10 Hz	– 20 dBm	(22 mV)	PLL Lock Range R272
		HIGH:	500 Hz	– 20 dBm	(22 mV)	None
	500 Hz – 20 KHz	LOW:	500 Hz	– 20 dBm	(22 mV)	PLL Lock Range R272
		HIGH:	20 KHz	– 10 dBm	(71 mV)	None
	20 KHz – 100 MHz	LOW:	20 KHz	– 20 dBm	(22 mV)	None
		HIGH:	100 MHz	– 5 dBm	(126 mV)	1 Meg Input Sensitivity Adjust R227
50 OHM	20 KHz – 100 MHz	LOW:	10 MHz	– 20 dBm	(22 mV)	None
		HIGH:	100 MHz	– 5 dBm	(126 mV)	None
	100 MHz – 1 GHz	LOW:	100 MHz	– 8 dBm	(90 mV)	100 MHz–1 GHz Level Adjust R250
		HIGH:	1 GHz	+ 10 dBm	(700 mV)	None

SERVICE AND WARRANTY

You have just purchased one of the finest frequency counters on the market today. The Sencore FC51 has been inspected and tested twice at the factory and has passed a rugged use test by our Quality Assurance Department to insure the best quality instrument to you. If something should happen, the FC51 is covered by the exclusive 100% Made Right Lifetime Guarantee as explained on the warranty policy enclosed with your instrument.

Sencore has one fully staffed and equipped National Service Center to serve you. Instruments to be serviced should be returned by UPS if possible. Parcel Post should only be used as a last resort. Instruments should be packed with the original packing material or equivalent, and double boxed to insure safe arrival at the National Service Center. The display carton is not an acceptable shipping container. When returning an instrument for service, be sure to state the nature of the problem to insure faster service.

If you wish to repair your own FC51, we have included a schematic and parts list. Any of these parts may be ordered directly from the National Service Center.

We reserve the right to examine defective components before an in-warranty replacement is issued.

Sencore National Service Center
3200 Sencore Drive
Sioux Falls, South Dakota 57107
(605) 339-0100

SENCORE

3200 Sencore Drive, Sioux Falls, SD 57107 (605) 339-0100

FORM 1802

PRINTED IN U.S

81436